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Identification of most important weed species in direct sown finger millet crop under rainfed condition of Jharkhand

Satish Kumar Pandey, Rajni Kiran Lakra, Usha Kumari and Twisha Chakravarty

Abstract
A field experiment was conducted on weed management practices in direct sown finger millet at Agronomical farm, Birsa Agricultural University, Ranchi during *kharif* season of 2016. The weeds were randomly sampled from the fields of finger millet crop using a quadrate of size 0.25 m x 0.25 m randomly thrown at 3 different sites. The data were recorded on weed density, relative weed density, weed frequency, relative weed frequency and importance value index of weeds. The experimental data showed that total 19 plant weed species, belonging to 12 families were collected and identified from the study area. The major weeds found, infesting the experimental field were *Commelina bengalensis* (L.) - 14.13%, *Echinocloa crusgalli* (L.) - 11.63%, *Cyperus rotundus* (L.) - 9.97%, *Ageratum conyzoides* - 9.14%, *Commelina nodifolia* (L.) - 6.65%, *Oldenlandia corymbosa* - 6.65% and *Dactyloctenium aegyptium* (L.) - 5.68%. Broad-leaf weed species were dominant throughout the growing period of crop. Grassy, broad- leaf and sedges accounted for 24.37%, 60.40% and 15.23%, respectively of respective weed flora of the experimental field. Therefore, integration of chemical, cultural and mechanical methods might be an answer to achieve greater weed control efficiency, which in turn may increase over all benefit of finger milletcultivation.

Keywords: Weeds species, Rainfed condition and finger millet

Introduction
Finger millet (*Eleusine coracana* L. Gaertn) is an important Kharif season crop of small millet group cultivated in rainfed tracks of hilly regions. It is ranks 6th important crop of world after rice, maize, wheat, sorghum and barley. It comprises of 5% of the total land devoted to cereals (Shinggu *et al*., 2009) [9]. It is grown on an area of 1.19 million hectare in India with a total production of 1.98 million tonnes and productivity of 1661 kg ha^{-1}. The major finger millet producing states are Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Bihar, Jharkhand, Gujarat, Maharashtra and the hilly regions of Utara Pradesh and Himachal Pradesh. The maximum area is covered in Karnataka 7.88 lakh hectare with a total production of 12.72 lakh tonnes and an average productivity of 1671 kg ha^{-1} (Anonymous, 2015) [1]. It is grown in an area of 13914 hectare in Jharkhand with a total production of 10412 tonnes and with an average yield of 748 kg ha^{-1} (Anonymous, 2016) [2]. The yield potential of finger millet in Jharkhand state is much lower than the national average. Since, the crop has slow growth habit in the initial stages; the weeds possessing faster growth habit can avail of this situation and offer severe competition to the crop for light, nutrients and moisture. The critical period of weed competition in finger millet is identified to be around 30 to 45 days after sowing and

further delay in the control of weeds leads to severe reduction in the grain yield was observed by Ramachandra Prasad *et al.* (1991) [7].

There are nearly 30,000 weeds species in the world, out of these 50 to 200 mostly cause considerable damage to the major food crops (Mahmood and Niaz, 1992) [4]. In India mostly loss in crop production takes place because of unchecked weed growing in different crops. It is expected that is loss in finger millet production is about from 30% to 50% is due to weeds. The enhanced finger millet crop qualities by using new variety, increase biodiversity and keep away finger millet crop from adverse effects of pest and climatic condition (Walburger *et al.*, 1999) [12]. Therefore, the following experiment was conducted to identify different weed species and the most dominant weed species in direct sown finger millet crop under rainfed condition of Jharkhand.

Materials and methods

Experimental area

A field experiment was conducted during *Kharif* 2016 at Agronomical Research Farm, Birsa Agricultural University, Ranchi, Jharkhand. The soil of the experimental field was sandy loam soil in texture with low in available organic carbon (3.13 g/kg soil) and available nitrogen (142.17 kg/ha) but medium in available phosphorus (18.55 kg/ha) and potassium (148.21 kg/ha) with a pH of 5.56.

Treatments and Experimental Design

The experiment consisting of twelve treatments was laid out in a randomized block design with three replications. The experiment was conducted in randomized block design replicated thrice with twelve different weed management practices viz., Pendimethalin (30 EC) @ 0.5 kg a.i./ha as pre-emergence (T1), Pendimethalin (30 EC) @ 0.75 kg a.i/ha as pre- emergence (T2), Bensulfuron methyl (0.6% G) + Pretilachlor (6.0% G) @ 2 kg/ha (pre-mix formulation) as pre-emergence (T3), Bensulfuron methyl (0.6% G) + Pretilachlor (6.0% G) @ 3 kg/ha (pre-mix formulation) as pre-emergence (T4), Isoproturon (50 WP) @ 0.5 kg a.i./ha as pre- emergence (T5), Pendimethalin (30 EC) @ 0.5 kg a.i./ha (PE) *fb* one inter-culture at 45 DAS (T6), Pendimethalin (30 EC) @ 0.75 kg a.i/ha as pre-emergence *fb* one inter-culture at 45 DAS (T7), Bensulfuron methyl (0.6% G) + Pretilachlor (6.0% G) @ 2 kg/ha (pre-mix formulation) as pre-emergence *fb* one inter-culture at 45 DAS (T8), Bensulfuron methyl (0.6% G) + Pretilachlor (6.0% G) @ 3 kg/ha (pre-mix formulation) as pre-emergence *fb* one inter-culture at 45 DAS (T9), Isoproturon (50 WP) @ 0.5 kg a.i./ha as pre-emergence *fb* one inter-culture at 45 DAS (T10), Weed free plot by one hand weeding at 20 DAS *fb* two inter-culture at 30 & 45 DAS (T11) and Weedy check (T12). The variety used for the experiment was A-404 with a spacing of 30 x 10 cm. A recommended dose of fertilizers (50:30:25 N: P2O5: K2O kg/ha) was applied equally to each plot. Nitrogen was applied in two splits. Half dose of N (25 kg/ha) along with full dose of P2O5 and K2O (30 and 25 kg/ha) were applied as basal and remaining N (25 kg/ha) was applied as top dressing after 30 days of sowing.

Data Collection

The weeds were randomly sampled from the fields of finger millet crop using a quadrate of size 0.25 x 0.25 m randomly thrown at 3 different sites.

The data were recorded on the following parameters:-

Weed flora

The weed flora associated with finger millet in the experimental field was identified at an interval of 60 days after sowing in weed check plot and listed accordingly. Weed flora was studied and classified into three categories viz: grasses, broad leaves and sedges.

Weed density m-2

Density of different weeds in each plot was studied at 60 day after sowing. An iron frame the quadrate, measuring 0.25 x 0.25 m was placed randomly at 3 spots in net plot area. Weeds within the quadrate were counted and classified into three categories viz: grasses, broad leaves and sedges. The observation was computed to give weed density or number of weeds per m^{-2}.

Relative weed density (%)

Relative weed density is the weed density of individual weed species with respect to the total weed density and it is expressed in percentage. It is calculated by using the following formula:

$$\text{Relative weed density (\%)} = \frac{\text{Density of individual weed species}}{\text{Total density of all weed species}} \text{ X } 100$$

Frequency (%)

Frequency can be a good indicator of the spatial distribution of a species within the experimental area. Weed frequency for each individual weed was computed by recording the occurrence of every weed in each quadrate and then multiplying with 100 for percentage as given in theformula.

Ecological analysis of the weed flora was carried out to determine the relative frequency (%) using the equation provided by Wirjahadja and Pancho (1978) [13]:

$$\text{Frequency (\%)} = \frac{\text{Number of quadrates placed where the species A occurred}}{\text{Total number of quadrates placed}} \text{ X } 100$$

Relative frequency (%)

Relative Frequency was determined by counting and recording the weed species within a

0.25 x 0.25 m quadrate was placed randomly at 3 spots in net area. It is calculated by using following formula:

$$\text{Relative Frequency (\%)} = \frac{\text{Frequency of species A}}{\text{Total frequency of all weed species}} \text{X } 100$$

Importance value indices (IVI)

The importance valve index for each individual weed was computed by adding the obtained valves of relative weed density and relative weed frequency, as given in the following formula:

IVI = (Relative weed density + Relative weed frequency) x 100

Results and Discussion Weed flora

Experimental field was infested with all three categories of weeds i. e. grassy, broad-leaf and sedges covering twelve families. Altogether 19 weed species (Grassy- 05, broad-leaf-12 and sedges- 02), belonging to 12 families were collected and identified from the study area (Table 1).

Weed density

The results on weed density of a particular species are shown in Table 2. The experimental field was infested with all three

categories of weeds i.e. grassy, broad-leaf and sedges covering thirteen families. Altogether nineteen weed species were observed. Among grasses, *Echinocloa crusgalli* (84), *Dactyloctenium aegyptium* (41) and *Eleusine indica* Gaerts. (35), in broad-leaf category - *Commelina bengalensis* (102), *Ageratum conyzoides* (66), *Commelina nodifolia* (48), *Oldenlandia corymbosa* (48), *Stellaria media* L. (40), *Alternanthra sessilis* (36) and *Coronopus didymus* (32) and in sadges - *Cyperus rotundus* (72) and *Cyperus esculentus* (38) weeds were dominant. Upasani *et al*. (2012) [10] has also endorsed that among grassy weeds *Eleusine indica* Gaerts. *Echinochloa crusgalli* (L.) P Beauv. Were dominant species. Mukherjee *et al*. (2008) [5] and Raj *et al*. (2013) [6] have also reported *Commelina benghalensis* L. as dominant broad leaved weed associated in the experimental field. Similarly, Upasani *et al*. (2012) [10] and Raj *et al*. (2013) [6] observed *Cyperus* species as dominant sedges in their experimental field.

Relative Weed Density (%)

The major weeds found, infesting the experimental field were *Commelina bengalensis* (L.) - 14.13%, *Echinocloa crusgalli* (L.) - 11.63%, *Cyperus rotundus* (L.) - 9.97%, *Ageratum conyzoides* - 9.14%, *Commelina nodifolia* (L.) - 6.65%, *Oldenlandia corymbosa* - 6.65% and *Dactyloctenium aegyptium* (L.) - 5.68%. Broad-leaf weed species were dominant throughout the growing period of crop. Grassy, broad-leaf and sedges accounted for 24.37%, 60.40% and 15.23%, respectively of respective weed flora of the experimental field. Yadav *et al*. (2005) [14] also reported that broad-leaf weed species were dominant in finger millet crop throughout the growing period at different locations. The results on relative weed density (%) present in the field are presented in Table-4 and fig.1.

Weed frequency (%)

The weed frequency of weeds is the best way of indication for the prevalence of weed species in the studied area. The results on weed frequency (%) of a particular species are shown in Table 2. On the basis of the data provided the highest frequency was computed for *Echinocloa crusgalli* L. P. Beauv, *Commelina bengalensis* L., *Ageratum conyzoides* L. and *Cyperus rotundus*

L. (100% respectively); while, the lowest (13.88%) frequency was recorded for *Cynodon dactylon* Pers., *Sorghum halepense* L. Pers., *Anagallis arvensis* and *Euphorbia hirta.* The remaining weeds included in the Table-2 were of minor phytosociological status and relatively unimportant as far as finger millet production in the target area is concerned. The study also expressed that maximum species of the field were broad leaf weeds with least number of grassy. The highest weed frequency in finger millet fields might be due to lack of weed management in the target area that's why, weeds reproduce more and are frequently occurring in finger millet crop. Saeed *et al.* (2010) [8] also reported the frequent occurrence of different weeds in their experiments. In a similar study, Khan *et al.* (2012) [3] also narrated the highest weed frequency for broad leaved weeds as compared to grassy weeds.

Relative weed frequency (%)

The relative weed frequency of weeds is the best way of indication for the prevalence of weed species in the studied area. The results on relative weed frequency (%) of a particular species are shown in Table 2. On the basis of the data provided the highest relative frequency was computed for *Echinocloa crusgalli* L. P. Beauv, *Commelina bengalensis* L., *Ageratum conyzoides* L. and *Cyperus rotundus* L. (9.60% respectively); while, the lowest (1.33%) frequency was recorded for *Cynodon dactylon* Pers., *Sorghum halepense* L. Pers., *Anagallis arvensis* and *Euphorbia hirta.* The remaining weeds included in the Table-2 were of minor phytosociological status and relatively unimportant as far as finger millet production in the target area is concerned. The highest weed frequency in finger millet fields might be due to lack of weed management in the target area that's why, weeds reproduce more and are frequently occurring in finger millet crop. Saeed *et al.* (2010) [8] also reported the frequent occurrence of different weed species in their experiments. In a similar study, Khan *et al.* (2012) [3] also narrated the highest weed frequency for broad leaved weeds as compared to grassyweeds.

Importance value index

The importance value index is important for understanding the status of a given weed specie in a weeds community. The data in Table-2 exhibits the highest importance value index (23.73%) was recorded for *Commelina bengalensis* L. followed by *Echinocloa crusgalli* L. P. Beauv (21.23%) and *Cyperus rotundus* L. (19.57%), while the lowest importance value index (2.44%) for *Cynodon dactylon* Pers., *Sorghum halepense* L. Pers., *Anagallis arvensis* and *Euphorbia hirta*. The highest importance value index of the above weed species is due to their high valve of relative weed density and relative weed frequency and are ought most important to be managed properly on time. The weeds should be control before threshold level, so that could not decrease finger millet productivity. These results are supported by those of Saeed *et al.* (2010) [8] who observed the highest importance value index for kharif weeds in their investigations. Waheed *et al.* (2009) [11] concluded that weed species such as also uniformly observed with IVI ranging from 6.70-44.45%.

Table 1: List of weed flora observed in the experimental field of the direct sown finger millet

Common Name	English Name	Botanical Name	Family	Annual/ Perennial
Grassy				
Sawa	Barnyard grass	*Echinocloa crusgalli* (L.) P. Beauv	Poaceae	
Makra	0Crow foot grass	*Dactyloctenium aegyptium* (L.)	Poaceae	
Banmadua	Goose grass	*Eleusine indica Gaerts.*	Poaceae	
Dub	Bermuda grass	*Cynodon dactylon* Pers.	Poaceae	
Jungli Sorghum	Johnson grass	*Sorghum halepense* (L.) Pers.	Poaceae	
Broad leaved				
Baskena	Day flower	*Commelina bengalensis* L.	Commelianaceae	
Mahkua	Tropical ageratum	*Ageratum conyzoides* L.	Asteraceae	
Kena	Common day flower	*Commelina nodifolia* (L.)	Commelianaceae	
Chimti	Diamond flower	*Oldenlandia corymbosa*	Rubiaceae	

Haddapota	Chick weed	*Stellaria media* (L.) Vallars	Chlorphyllaceae	
Garundi	Wetland amaranth	*Alternanthra sessilis* (L.)	Amaranthaceae	
Bangajar	Swine-cress	*Coronopus didymus* (L.)	Brassicaceae	
Bundhania	Corn spurry	*Spergula arvensis* L.	Coryophyllaceae	
Safed murgfull	White Cock's comb	*Celosia argetea* L.	Amaranthaceae	
Hajardana	Gripe weed	*Phyllanthus niruri* Hook. F.	Euphorbiaceae	
Krishnanil	Scarlet pimpernel	*Anagallis arvensis*	Primulaceae	
Mothi dudh	Garden spurge	*Euphorbia hirta*	Euphorbiaceae	
Sedges				
Motha	Purple nut sedge	*Cyperus rotundus* L.	Cyperaceae	
Bara-nagar motha	Yellow nut sedge	*Cyperus esculentus* L.	Cyperaceae	

Table 2: Weed density (m^{-2}), relative weed density (%), weed frequency (%), relative weed frequency (%) and IVI for the individual weed species of the direct sown finger millet

Botanical Name	Weed density (Number/m^2)	Relative Weed Density (%)	Frequency (%)	Relative Frequency (%)	Importance value index
Grassy					
Echinocloa crusgalli (L.) P. Beauv	84	11.63	100	9.60	21.23
Dactyloctenium aegyptium (L.)	41	5.68	75.00	7.20	12.88
Eleusine indica Gaerts.	35	4.85	55.55	5.33	10.18
Cynodon dactylon Pers.	8	1.11	13.88	1.33	2.44
Sorghum halepense (L.) Pers.	8	1.11	13.88	1.33	2.44
Broad leaved					
Commelina bengalensis L.	102	14.13	100	9.60	23.73
Ageratum conyzoides L.	66	9.14	100	9.60	18.74
Commelina nodifolia (L.)	48	6.65	83.33	8.00	14.65
Oldenlandia corymbosa	48	6.65	83.33	8.00	14.65
Stellaria media (L.) Vallars	40	5.54	75.00	7.20	12.74
Alternanthra sessilis (L.)	36	4.99	55.55	5.33	10.32
Coronopus didymus (L.)	32	4.43	27.77	2.67	7.10
Spergula arvensis L.	16	2.22	19.44	1.87	4.09
Celosia argetea L.	16	2.22	19.44	1.87	4.09
Phyllanthus niruri Hook. F.	16	2.22	19.44	1.87	4.09
Anagallis arvensis	8	1.11	13.88	1.33	2.44
Euphorbia hirta	8	1.11	13.88	1.33	2.44
Sedges					
Cyperus rotundus L.	72	9.97	100	9.60	19.57
Cyperus esculentus L.	38	5.26	72.22	6.93	12.19
Total	722	100%	1041.59	100%	

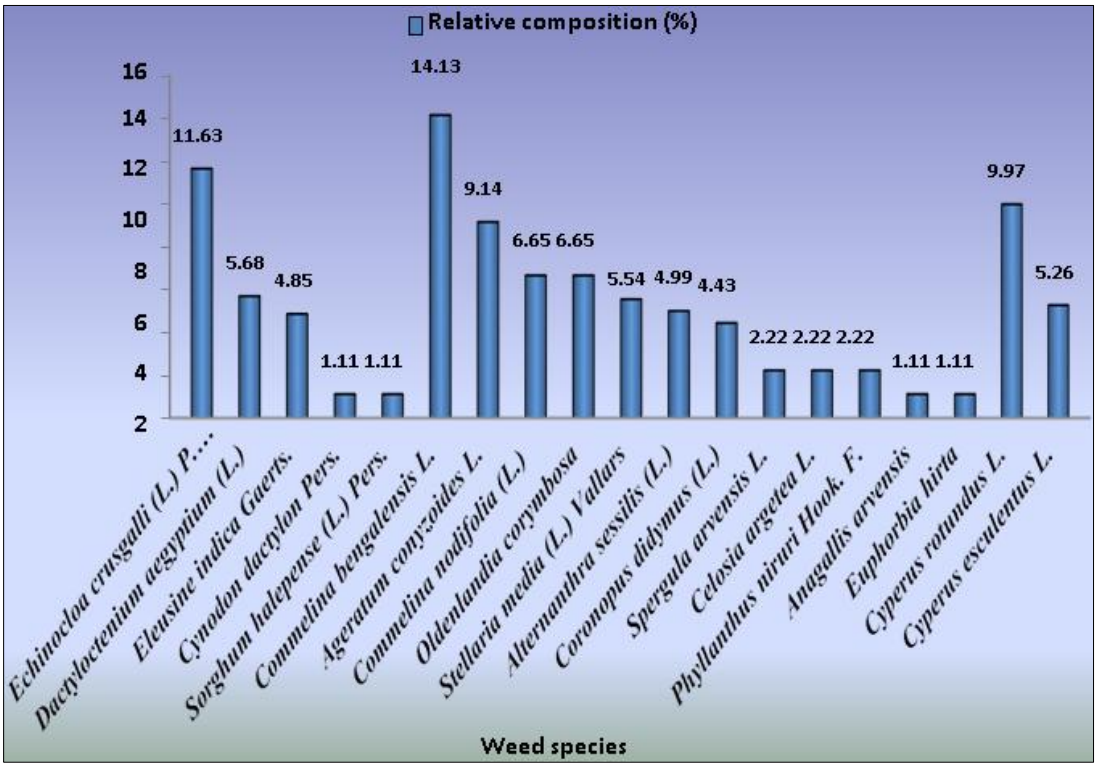

Fig 1: Relative density (%) of weed species observed during experimentation

Conclusion

There was a diverse weed flora present in finger millet fields indicating that finger millet is vulnerable to weed infestation and competition, as indicated by the important valve indices of the weeds. Among the different identified weeds *Echinocloa crusgalli* L. P. Beauv, *Commelina bengalensis* L., *Ageratum conyzoides* L. and *Cyperus rotundus* L. are the most problematic weed of finger millet crop in direct sown finger millet crop under rainfed condition of Jharkhand. This study provided very helpful knowledge to the scientific community about weed flora to design a solid integrated weed management plane in finger millet crop in the target area. Similar studies should be carried out for timely information and resolution of issues related to farming system.

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