JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue

JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)

An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Distribution, management implications and yield impact of *Echinochloa crus-galli* (L.) Beauv. in the rice field of District Baramulla (JK) India : A case study

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Abstract: The present study was undertaken to investigate the impact of *Echinochloa crus-galli* (L.) Beauv. (barnyard grass) as a weed on rice cultivation in District Baramulla (JK). *Echinochloa crus galli* belongs to the Poaceae family and is a competitor of rice plants in standing water fields. The experimental work was carried out during 2020-2021. Representative rice plots of 20 × 20m were selected in different areas. 15 quadrats of 5× 5m were randomly laid within the rice plot and results were recorded (quantitatively and qualitatively) at different stages of rice cultivation. Qualitative analysis showed the regular presence of weeds in every quadrant. Moreover, quantitative analysis also proved significant reduction in rice yield due to *Echinochloa crus-galli*. However, traditional methods known as *"Nind"* (removal by hands) and spikelet cutting are commonly used by farmers but are time consuming and less effective to manage this weed. A number of common herbicides viz. Bispyribac Sodium, Butachlor granules, Anilophos and Ethoxy sulfuron are also used by farmers to control this weed. Therefore, the present study revealed the distribution, management implications and rice yield impact of *Echinochloa crus-galli* in the rice fields of District Baramulla (JK).

Keywords: *Echinochloa crus-galli* (L.), Barnyard Grass, Poaceae, Baramulla, Traditional

Introduction

Echinochloa crus-galli (L.) Beauv. is a well known weed of this genus, world- wide distributed and marked as the third and fourth (with its two species) most important weed. (Holm et al.1977). It is an annual grass belonging to the family Poaceae with emergent roots and flowers from June to July. It is specifically adapted to temperate regions and anaerobic conditions prevailing in rice fields and wetlands. Moreover, it has the ability to mimic rice, speedy germination, grow very quickly and produce enormous seed with broad ecological tolerance, making it a potential weed worldwide (Barrett,1983).

Echinochloa crus-galli is marked as the most destructive weed in agriculture practices (Micheal,2003; Leeson et al., 2005; Heap2014a) with the acquired ability to grow in varied climatic conditions (Marambe and Amarsinghe, 2002). *E. crus-galli* is the dominant weed of rice field crops (Chauhan

and Johnson, 2011) and is considered as an important weed of rice field in reduced soil conditions (Rao et al., 2007). It appears as a tenacious competitor in the rice field and other crops due to its morphological, physiological, and biochemical characteristics (Maun and Barret, 1986; Clay et al., 2005). In South Asia, a major biological constraint is composed by the weeds (Rao and Ladha, 2014; Rao and Yaduraju, 2015; Rao and Wani, 2015). A number of weed species of economic significance associated with rice have been reported earlier viz. *Echinochloa colona* (L.) Link, *Echinochloa crus-galli* (L.) Beauv, *Cyperus rotundus* L., *Alternanthera sp*., *Commelina benghalensis* L., *Ammania sp*., Dinebra *sp*. (Rao et al. 2014). In Kashmir Valley, forty species of weeds have been reported from different rice fields (A H Gani et al., 2015; 2016). It was observed that *Echinochloa spp.* was more competitive and caused huge losses in rice yield in comparison to *Marsilea quadrifolia, Cyperus difformis* and *Eclipta prostrata* (Srinivasan and Palaniappan, 1994). Several countries used intensive chemicals as management practices to reduce *E. crus-galli* infestation in rice fields (Gibson et al.2003; Hoagland et al. 2004). However, due to the resulting reduced yield in rice, it still persists as the most economically important weed (Hassan et al. 1994; Pandey 1996; Smith 1988). Moreover, it is also considered as the most dangerous herbicide-resistant weed of the world (Beckie, 2006). Traditionally, farmers have adopted various methods to remove and prevent growth of *Echinochloa crus-galli* in rice fields but these have been rated as most laborious in rice culture (B L Putto, 2008). The objective of this study was to investigate the distribution, management implications of *E. crus-galli* as well as impact on rice yield in the rice field of District Baramulla (JK).

Material and Method

1.1. Study area

Baramulla is one of the 22 Districts in J&K Union Territory and is the largest District in terms of both area and population. Baramulla covers an area of 2072.42km^2. The Union Territory of Jammu & Kashmir constitutes the Northern most extremity of India and is situated between 320.17 D and 360.58 D N latitude and between 370.26 D and 800.30 D E longitude. The District with it's headquarter at Baramulla town lies between 34˚11′53′′ N and 74˚21′50′′E at a height of 1850 m (6069 ft.)

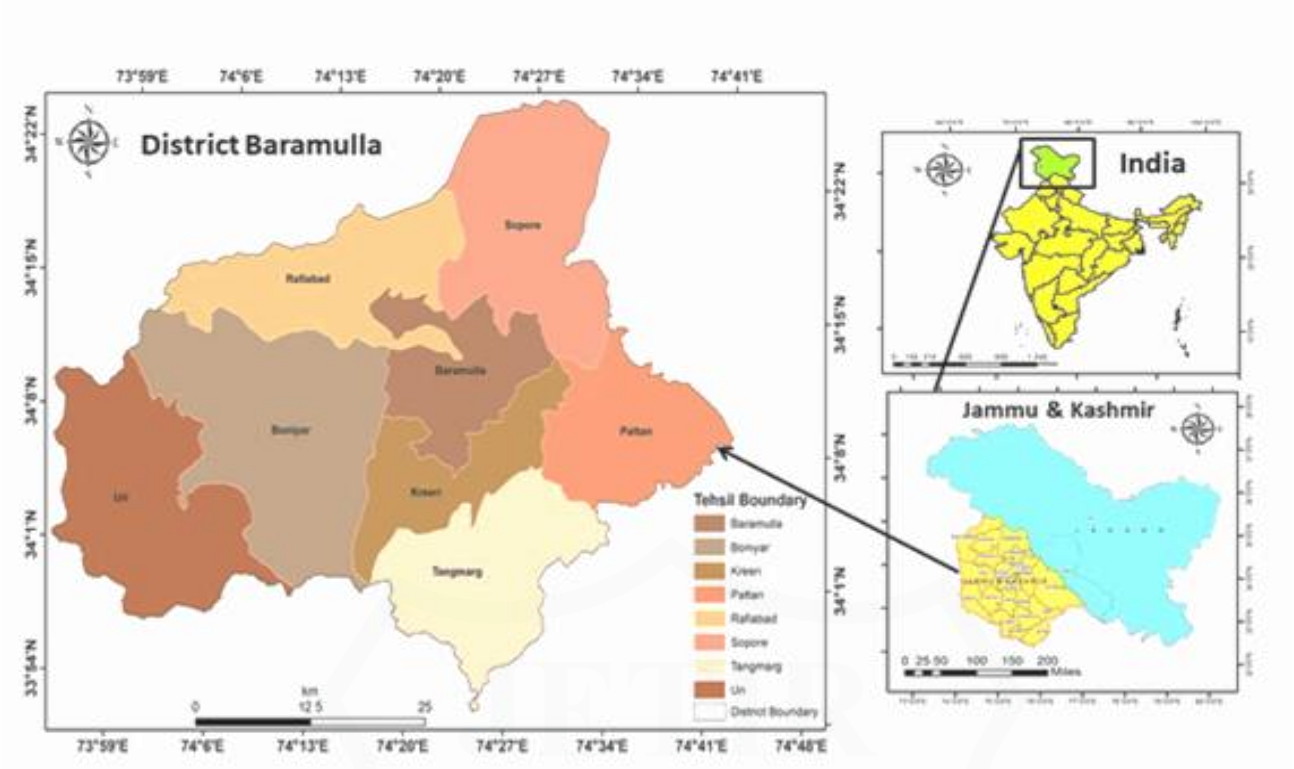

Figure 1.1: Map showing study area

1.2. Field survey

Field work was carried out in the year of 2020-21 in different rice fields of the District Baramulla to know the effect of *Echinochloa crus-galli* on rice production. Proper notes were prepared in different stages of rice cultivation from seed sprouting to harvesting of rice. The effect of *Echinochloa crus-galli* both quantitatively and qualitatively was recorded at different stages of rice cultivation. During the field survey, information was also collected from farmers about rice cultivation and traditional methods to overcome the weed and to get rid of it.

1.3. Distribution

Representative rice plots of 20 × 20m were selected in different areas. 15 quadrats of 5× 5m were randomly laid within the rice plot. Quadrats were laid to know the distribution of *Echinochloa crus-galli* in rice plots. Similar quadrats were laid in the rice nursery and dominance of *Echinochloa crus-galli* were recorded separately, given in Table 1.1 and 1.2.

Results and Discussion

In the beginning, the nursery is prepared for sprouting rice seeds. During the sporulation process, seeds of *Echinochloa crus-galli* are also sprouted in the nursery. The carrier of seeds of *Echinochloa crus-galli* is water, present with dry rice seeds or may already be present in crop fields. In a nursery, it is very difficult to identify *Echinochloa crus-galli* in vegetative phase because rice and *Echinochloa crus-galli* are morphologically much similar. They can be identified after formation of spikelets, as they are not formed in the early stage. After attaining certain growth, rice seedlings are uprooted from the nursery to transfer into standing water fields. Using traditional methods, seedling bundles of suitable size are formed locally known as *"Tol"*. *Echinochloa crus-galli,* during this process, is somehow removed from seedling bundles. But still some seedlings of *E. crus galli* remain with rice seedling bundles.

Table 1.1. Distribution of *Echinochloa crus- galli* in nursery in Tehsil Pattan of District Baramulla

Quadrant No.	Number of *Echinochloa crus-galli* individuals	Season
1	3	April
2	4	April
3	1	April
4	3	May
5	2	May
6	1	May
7	-	May- June
8	1	May- June
9	3	May- June
10	2	May- June

Rice seedlings are transferred into waterlogged fields for further growth. These prepared rice fields also possess *E. crus - galli* seeds which germinate with rice seedlings. *Echinochloa crus-galli* grows along with rice seedlings. Local farmers have given *Echinochloa crus-galli* two names on the basis of location in the standing water fields of rice, namely "*Al-ham*" and "*Kuj-ham*. Al-ham is present outside rice plants while as kuj- ham is present with rice plants. Al-ham is less effective as it can be removed using traditional methods or weedicides. Kuj-ham is more effective as its competitor of rice. Growth of *Echinochloa crus-galli* occurs along with rice until a spikelet is formed and fruit set occurs.

Table 1.2 Distribution of *Echinochloa crusgalli* in rice beds in Tehsil Pattan of District Baramulla

Quadrant No.	Number of *Echinochloa crus-galli* individuals	Season
1	2	July
2	2	July
3	1	July
4	-	September
5	-	September
6	1	September
7	2	September
8	1	October
9	-	October
10	1	October

Effect of *Echinochloa crus-galli* on rice yield

Rice bundles containing seedlings of *Echinochloa crus-galli* compete with rice for nutrition due to which more fertilizers are needed. Farmers can't buy costly fertilizers to overcome the loss caused by *Echinochloa crus-galli.* Due to the presence of *Echinochloa crus-galli*, rice seedlings there occur stunted growth of rice and also affect the fruit set. Some seeds of *Echinochloa crus-galli* remain with rice seeds, which becomes awful during eating.

Quantitative analysis

To determine the effect of *Echinochloa crus-galli* in rice yield, different rice plots of the same area were put under observation. Some of the rice plots were with *Echinochloa crus-galli* and some were without *Echinochloa crus-galli* in equal ratio. Rice plots were harvested and thrashed separately. It was recorded that 2kg of rice on an average was reduced from the plots with *Echinochloa crus-galli.*

The loss in rice yield due to the presence of *E. crus-galli* has been already studied. The present investigation also confirms the significant loss in rice yield caused by *E. crus-galli*. The highest possible crop yield loss due to weed is 34% in comparison to 18 and 16% by insect pests and pathogens, respectively (Oerke, 2006). The loss in yield was maximum in case of *E. crus-galli* in comparision to other common weeds of rice field viz. *Marsilea quadrifolia*, *Cyperus difformis* and *Eclipta prostrata* (Srinivasan and Palaniappan, 1994). The recent investigation established that loss in rice yield was very low under specific circumstances where *E. crus-galli* emerged at a later stage in the rice field (T H Avan et al., 2021).

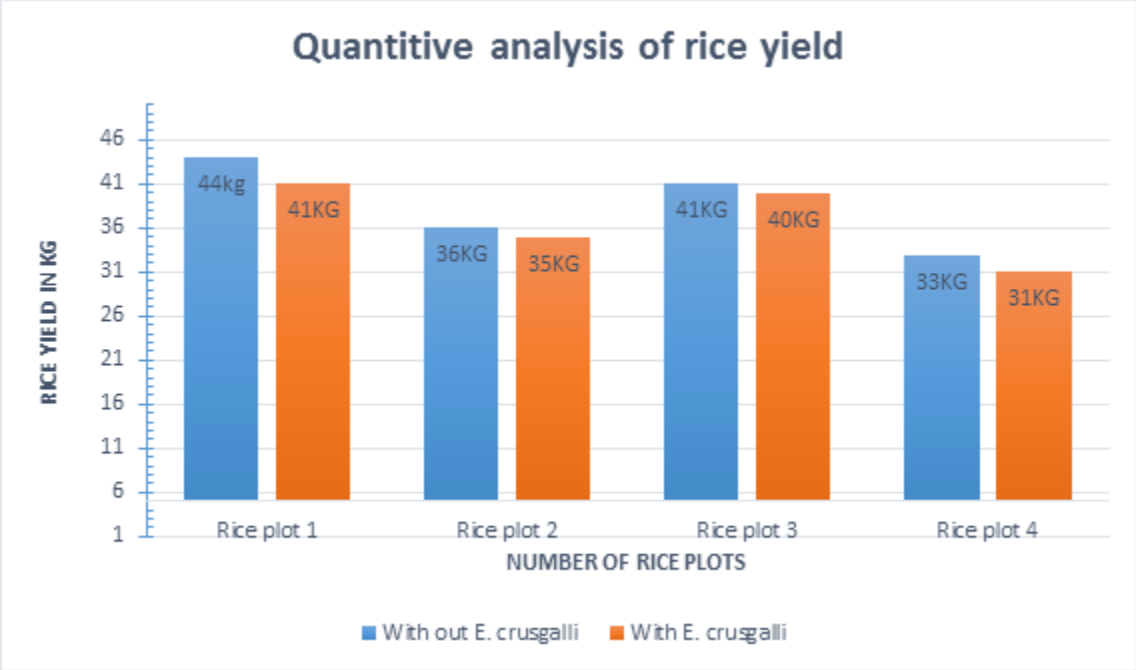

Figure 1.2: Quantitative effect of *Echinochloa crus-galli* on rice yield.

Management implications

Echinochloa crus-galli is a potential weed and is difficult to remove physically or by the action of herbicides. Farmers still have adapted different traditional methods to remove *Echinochloa crus-galli.* During rice sprouting it is difficult to remove this weed physically because its vegetative phase is similar to that of rice seedlings. However, having proper knowledge of identification, both can be separated in vegetative phase. *Echinochloa crusgalli* has white culms and roots while rice (*Oryza sativa)* has brown stems and roots. One of the

traditional methods is destroying *Echinochloa crus-galli* seeds present in nursery beds by collecting dry grasses and burning them in order that the seeds get destroyed. During transfer to rice beds, *Echinochloa crus-galli* is removed physically but takes more manpower and is time consuming.

In rice fields, *Echinochloa cru-sgalli* is removed by hand which is locally known as *"Nind".* Removal by hand is effective for weeds present outside rice plantations (Al-ham). This process is done three to four times till harvesting. Earlier studies have also shown that hand hoeing is useful to manage *E. crus-galli* particularly for small farms (Shibayama, 2001; Akbar et al., 2011).

Another traditional method is cutting spikelets of *Echinochloa crus-galli* so that seeds will not fall into the field for future cultivation of rice. However, it's also time consuming and is cost effective. This method is least applied by farmers and is only practiced in some areas of the District Baramulla. *Echinochloa crus-galli* is also separated from rice during harvesting, so that seeds will not mix up with seeds of rice during thrashing. If seeds of rice and *Echinochloa crus-galli* mix up, weeds will germinate again next year during cultivation of rice.

In India, the overall herbicide consumption has increased by almost two and half times between 2005 to 2015 (Das Gupta et al., 2017). The application of herbicide for the management of *E. crus-galli* depends upon the method, alternative combinations, applied dose and appropriate applicable time. There are various herbicides used by farmers to destroy weeds found in rice fields. The most common and effective herbicide used is Nominee gold. *E. crus-galli* is effectively controlled by the use of Pendimethalin and oxadiargyl alternately with bispyrabac -sodium (Singh et al., 2015). Butachlor and propanil resistance have been reported in *E. crus-galli* populations that are derived from direct-seeded rice (Juliano et al. 2010). The regular and continuous use of the same herbicides has evolved resistance in the weeds (Valverde, 2007).

Table 1.3: Details of specific chemical herbicide

Trade name	NOMINEE GOLD
Common name	Bispyribac sodium
Action	Systematic herbicide
Dosage	Low dosage of 80-120ml/acr
Formulation	10% SC

Table 1.4: Details of general chemical herbicides

S. No.	Name
1	Butachlor granules
2	Anilophos and Ethoxy sulfuron

Conclusion

In conclusion, *Echinochloa crus-galli* is a noxious weed due to it's invasive behavior, and herbicide resistance. The weed accounts for considerable losses in rice crop yields through weed-crop competition. However, physical and chemical methods have been used to manage this noxious weed but still they are not very effective.

Research needs to be focused on integrated weed management strategies to elevate the problems of biological invasion and herbicide resistance.

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