Weed density and diversity in jute under long-term experiment in jute-rice-wheat cropping system

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ABSTRACT
Studies on the impact of long-term fertilizer application on changes in weed community composition are important and likely to provide insight into the effects of prolonged fertilizers on weed community structure and infestation. Nine treatments of long term fertilizers experiment, viz. (i) control (plots which did not receive NPK fertilizers or farm yard manures (FYM) (ii) 50% of recommended doses of NPK (iii) 100% NPK (recommended dose of fertilizers) (iv) 150% NPK, (v) 100% NPK + hand weeding (No herbicides application in jute, rice and wheat (vi) 100% NPK + Zn (vii) 100% NPK+FYM 10 t/ha/year before sowing of jute with four replication were included in the present investigation. A total of 12 weed species were recorded under different fertilizer treatments. Significantly higher total weed density (733/m²) was recorded in 100% NPK + FYM treatments compared to other treatments. Significant variation in weed species was also recorded in different fertilizers treatment. Cyperus rotundus density was comparatively higher in control, 50% NPK and 100% NPK + Hand weeding plot. Echinochloa colona density was higher in 150% NPK, 100% NPK + Zn and 100% NP. Comparatively higher broad-leaved weed density were recorded in 100% NPK + FYM. The highest Shannon-weiner index (H'=2.02), Simpson diversity index (D'=0.81) and weed species evenness (E'=0.81) were recorded in 100% NPK + FYM and the lowest (H'=1.0, D'=0.62 and E'=0.5) in control plot. Thus, weed management strategies in FYM applied jute field should be given highest priority for getting higher fibre yield.

Key words: Fertilizers, FYM, Jute, LITE, Weed diversity, Weed management, Yield

Weeds are important components of agricultural ecosystems. Weed communities and their diversity play a significant role in determination of the nature of weed management strategies to be adopted in crops and cropping system (Storkey and Cussans 2007). Development of integrated weed management strategy needs knowledge of weed ecology and biology in agro-ecosystems (Wilson et al. 2009) and inclusion of multiple tactics, such as the prevention, avoidance, monitoring, and suppression of weeds (Buhler 2002). Fertilizer application is one of the most widespread agronomic practices that are used to improve soil fertility and enhance crop productivity. Simultaneously, it significantly affects weed growth and its community composition directly through affecting soil nutrient availability and indirectly through intensifying resource competition between crops and weeds and results in new selective pressures to weed species and thus change the occurrence frequencies (Das and Yaduraju 1999, Andreasen and Skovgaard 2009, Smith et al. 2010).

While improving the crop’s yield and quality, fertilizers profoundly influence the diversity of the whole weed community and its individual component (Wan et al. 2012). To fulfill the increasing demand of jute fibre. It is inevitable to increase the productivity in a sustainable manner as the area under jute is constant since last 30 years. The weeds in jute fields are considered as a major problem as they reduce fibre yield up to 80% and hence, it is inevitable to develop weed management strategies to control weeds (Ghorai 2008, Ghorai et al. 2013). Studies on the impact of long-term fertilizers application on changes in weed community composition are important and are likely to provide insight into the effects of prolonged fertilizer use on weed community structure and infestation. Therefore, this study was undertaken to examine the effect of long term uses of manure and fertilizer application on density and diversity of weeds in jute to provide a scientific basis for developing an integrated weed management strategy for jute under jute-rice-wheat cropping system.

MATERIALS AND METHODS
A long-term field experiment was established at the Central Research Institute for Jute and Allied Fibres (CRIJAF) Barrackpore (22°45’ N, 88°26’ E, 9.0 m msl) in 1971 on the new alluvial soil in the hot
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Humid sub tropic of eastern India for jute (Corchorus olitorius L)-rice (Oryza sativa L)-wheat (Triticum aestivum L)- cropping system. The soil was a sandy loam (hyperthermic, typic eutrochrept, US soil taxonomy). The experiment was laid out in randomized block design (RBD) and all the plots were separated by concrete ridges and irrigation furrows to provide irrigation plot by plot. Seven treatments, viz. (i) control (plots which did not receive NPK fertilizers or farm yard manures (FYM) (ii) 50% of recommended doses of NPK (iii) 100%NPK (recommended dose of fertilizers) (iv) 150% NPK, (v) 100% NPK + hand weeding (No herbicides application in jute, rice and wheat (vi) 100% NPK + Zn (vii) 100% NP, (viii) 100%N (ix) 100% NPK+FYM at 10 t/ha/year before sowing of jute with four replication were included in the present investigation. Recommended doses of N-P-K for jute were 60–13–25 kg/ha.

The N, P and K fertilizers was applied in the form of urea, single super phosphate and muriate of potash, respectively. After harvesting of wheat in the month of last week of March, the land was prepared for sowing of jute. The weed control in jute was done manually by hand weeding and/or wheel hoe or by scrapper and butachlor at 1.0 kg/ha at 20-25 DAS. For weed control in rice, butachlor at 1.0 kg/ha was applied 10 days after transplanting (DAT) followed by one manual weeding at 30-35 DAT. For controlling the weed in wheat, 2,4-D at 500 g/ha was applied followed by one manual weeding at 45 DAS.

The sample of weeds was collected by using four randomly selected 0.5 × 0.5 m quadrat (0.25 m²) in each plot of size 20 × 10 m before weeding at 25 DAS in both 2012 and 2013. Weeds falling in quadrats were counted species wise, calculated and presented in number of weeds/m² and were transformed prior to analysis, using square root transformation \( \sqrt{(x + 0.5)} \). Importance Value Index (IVI) of a plant species was calculated to have overall picture of ecological importance of a species in relation to community structure by adding relative frequency, relative density and relative dominance. The biodiversity of the weeds was measured including: the species richness \( R \) (i.e. the total number of species occurred in field); the species diversity, which was measured by the Shannon-Wiener index \( i.e. H' = -\sum P_i \log P_i \), in which \( P_i \) is the proportion of individual numbers of the \( i \) species to the total individual number of each species in the quadrats. It was calculated from the formula as \( P_i = N_i/N \), of which \( N \) is the total individual number of each weed species and \( N_i \) is the individual number of the \( I \) species; the degree of community dominance, as measured by the Simpson index, \( D = 1−P^2 \); the community evenness, as measured by the evenness index (Pielou index), \( J = H'/\log S \). The Duncan Multiple Range Test (DMRT) was worked out where variance ratio (‘F’ test) was significant at \( P \leq 0.05 \) by using SPSS v. 16.0.

**RESULTS AND DISCUSSION**

A total of 12 weed species observed in the experimental plots were *Cyperus rotundus*, *Brachiaria ramose*, *Digitaria sanguinalis*, *Echinochloa colona*, *Eleusine indica*, *Amaranthus viridis*, *Physalis minima*, *Cleome viscosa*, *Digera arvensis*, *Phyllanthus niruri*, *Portulaca oleracea* and *Trianthema portulacastrum*. Application of different doses of fertilizers affected the weed community and composition in jute. The significant difference (\( P=0.05 \)) in total weeds density was observed among different manure and fertilizers treatments (Table 1). Significantly higher weed density was recorded in 100% NPK+FYM treatments compared to all other treatments. The weed density in 150% NPK, 100% NPK and 50% NPK was almost similar but higher than control and 100% NP treatment.

The influence of fertilizers on weed density has been reported by many researchers (Moss *et al.* 2004, Wan *et al.* 2012). Das and Yaduraju (1999) in wheat, Nie *et al.* (2009) in rice and Mohammaddoust *et al.* (2009) in barley reported that balanced nutrient and higher NPK favoured crop growth but in case of jute, because of its very small and delicate seedling and non-tillering behaviour, it cannot compete with weed during initial 20-25 days. Weed density in 100% NPK + HW was also significantly higher than other treatments except 100% NPK + FYM. Species wise variation in weed density was also observed in different fertilizers and manure treatments. *Cyperus rotundus* density was higher in control and 50% NPK and 100% NPK + HW treatments. Among the grass, weeds *Echinochloa colona* density was the highest in 100% NPK + Zn, 150% NPK and 100% NPK + FYM treatments. Density of broad-leaved like *Physalis minima* and *Phyllanthus niruri* was higher under 100% NPK + FYM. Weeds like *Brachiaria ramose* and *Digera arvensis* were only recorded in 100% NPK + FYM plot. Different fertilizer treatments had different levels of available N, P and K in soil which influenced weed density and its growth. Banks *et al.* (1976) observed that total weed density was lowest in plots receiving no fertilizer and highest in these plots receiving N, P, K, while some weed species populations decreased as fertility became more balanced.
was observed in lower doses of fertilizers. Slow growth of the crop in control (no fertilizer) and fertilizers was very difficult to control. It has been reported as one of the weeds that established in the field, it is a perennial sedge, which can be controlled by introducing species as FYM is a good alternative. Brachiraia ramose (0.0) and higher densities were recorded in 100% NPK + FYM. NPK and higher fertilizers doses. The highest weed density was observed in 100% NPK + FYM. The type of manure that was applied in this experiment was cow dung with waste of grass clippings. The type of manure that was applied in this experiment was cow dung with waste of grass clippings.

Although, fertilizers clearly promoted crop growth, many studies have shown that nutrients benefit crops more than weeds (Liebman and Davis 2000, Sindel and Michael 1992). Thus, the effects of fertilization on weed density may vary with weed species and their composition. Dominance of Cyperus rotundus was observed in lower doses of fertilizer application and had an Importance Value Index (IVI) of 157,144 and 118 in control, 50% NPK and 100% NPK + hand weeding, respectively. (Table 2.) Cyperus rotundus is a perennial sedge, which can survive with low available nutrients, as it propagates mainly through vegetative parts (tubers and rhizomes) and once it is established in the field, it is very difficult to control. It has been reported as one of the worst weeds in the world (Holm 1977). Furthermore, Cyperus dominated in fields because of slow growth of the crop in control (no fertilizer) and 50% NPK treatment. Once Cyperus established with a higher density, it did not allow the growth of other weed species (Kumar et al. 2012).

Dominance of Echinichloa colona was recorded in 100% NPK+ Zn (IVI=110), 100% NP (IVI=106) and 150% NPK (IVI=82) i.e. in balanced and higher fertilizers doses. The highest weed density of broad-leaved weeds was recorded in 100% NPK + FYM. The type of manure that was applied in this long-term experiment was cow dung with waste of feeds that was derived from dairy farms; weeds like Echinichloa colona, Digeria arvensis, Phyllanthus niruri, Physalis minima are used as animal feed in this area and these may have returned to field with FYM. FYM affects weed species diversity by increasing seed density or by introducing species as FYM is a source of many weed seeds (Cook et al. 2007, Walia et al. 2014).
Weed diversity

The weed species richness (R) was the highest (12) in 100% NPK + FYM and the lowest (5) in control plot (Fig. 1). The species richness under all other treatments was in order of 150% NPK (9) > 100% N (8) = 100% NPK + Zn (8) > 100% NPK (7) > 50% NPK and was higher in 150% NPK and 100% NPK + FYM treated plots because of higher density of broad-leaved weeds and higher available nutrient in this treatment which enhances germination and weed growth of many weed species (Charles et al., 2006).

The weed diversity (Shannon’s H1) was significantly higher (P < 0.05) in 100% NPK + FYM and lower in control plot compared to other treatments (Fig. 1). If weed species are equally distributed, the diversity and evenness will be more but dominance of some weed species will lead to decrease in diversity and evenness of weed species in an ecosystem (Wilson et al. 2003). Cyperus was dominant in control plot and 50% NPK treatments led to decrease in the weed diversity. The Simpson diversity index (D’) was significantly higher in 100% NPK + FYM and 100% N compared to other treatments. The higher weed diversity in 100% NPK + FYM due to high available nutrients and weed species diversity was also affected by FYM as it is source of many weed seeds (Liemann and Davis 2000).

The weed species evenness (E’) in 100% NPK + FYM and 100% N was almost same but significantly higher compared to other treatments. The lowest Simpson Index in 100% NPK + hand weeding and control plot was mainly due to the highest density of Cyperus rotundus in this treatment as Cyperus was dominant in control plot. Hand weeding is not effective in managing Cyperus as it grows from vegetative underground parts and hence long term use of single method of weed control increases the density of Cyperus in hand weeding plot.

Thus, it may be concluded that recommended doses of fertilizer recorded medium levels of weed density, and higher level of NPK and NPK integration with FYM recorded higher weed density and diversity. Higher infestation of Cyperus rotundus was recorded under lower doses of fertilizer while, higher infestation of Echinochloa colona was recorded under higher doses of fertilizers. The highest weed species richness and diversity was observed under 100% NPK + FYM (10 t/ha) treatment. Hence, weed management practices in FYM applied field should be given the highest priority.

REFERENCES


