

## EFFECT OF NITROGEN SOURCES AND WEED MANAGEMENT OPTIONS ON WEED GROWTH AND CROP YIELD OF TRANSPLANT *AMAN* RICE

R. Ghosh<sup>1</sup>, M. Salim<sup>1</sup> and S. Ahmed<sup>1, 2</sup>

<sup>1</sup>Agronomy Division, Bangladesh Agricultural University, Mymensingh, Bangladesh

<sup>2</sup>International Rice Research Institute, Bangladesh

\*Corresponding author's email: s.ahmed@irri.org

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### Abstract

A field study was conducted at the Agronomy research field of Bangladesh Agricultural University, Mymensingh, during the period of July to December, 2013 to evaluate the sources of nitrogen and weed management options on weed growth and rice yield. The experiment included four nitrogen sources (100% cowdung, 100% prilled urea, 100% urea super granule, 50% cowdung + 50% prilled urea) and four weed management options (weedy, application of herbicide at 3 DAT, application of herbicide at 3 DAT followed by hand weeding at 21 DAT and weed free). Sources of nitrogen and weed management options had significant effect on tiller number, biomass, SPAD value, panicle number, number of florets panicle<sup>-1</sup>, grain and straw yield, and weed biomass. The highest grain yield (5.40 t ha<sup>-1</sup>) was found in the treatment of 50% cowdung + 50% prilled urea with combination of season long weed free. Although 100% prilled urea had significantly similar grain yield to 50% cowdung + 50% prilled urea, however, across the weed management options, 100% urea super granule and 100% cowdung had 15 and 27% lower grain yield. Irrespective of the weed management options, 100% prilled urea had always higher weed biomass and 100% USG, 50% cowdung + 50% prilled urea, and 100% cowdung had 46, 35 and 19% lower weed biomass, respectively, compared with 100% prilled urea. In terms of rice yield and weed management, combined application of organic and inorganic source of nitrogen is better than only chemical or only organic source and pre-emergence herbicide followed by one hand weeding for transplanted *aman* rice.

### Introduction

In Bangladesh, there are three distinct rice growing seasons such as *aus*, *aman* and *boro*. Among them, *aman* covers more than half of the rice area accounting 5.61 million hectares with a production of 12.89 million tons of rice (BBS, 2013). It was always reported that in *aman* season yield gap between farmers and researcher is always higher and it is mainly due to imbalanced use of fertilizer and lack of inadequate pest management (Salam *et al.*, 2004). Application of inorganic N fertilizer is considered to be most effective measures for improving rice production. Unfortunately, fertilizer nitrogen (N) is not utilized efficiently in the world agriculture and the recovery of N in cereals, at global level is reported to be less than 40% (Raun and Johnson, 1999; Raun *et al.*, 2002). Inorganic prilled urea (PU) is the principle source of N for rice production in Bangladesh; however, in *aman* season crop can utilize less than 40% of applied nitrogen (Ali *et al.*, 2006). This is due to low recovery efficiency of N is associated with its high losses by leaching, denitrification, and volatilization (Fageria and Baligar, 2005). Urea super granule (USG) is an alternate source of nitrogen fertilizer and becoming popular to the farmers.

Weeds are the greatest yield-limiting pest to rice production (Ahmed and Chauhan, 2014). Global yield losses due to pests have been estimated approximately 40% where weeds caused the highest loss which is around 32% (Rao *et al.*, 2007). The weather condition of *aman* rice season in Bangladesh is highly favorable for the enormous growth of weeds (Ahmed and Chauhan, 2015). The rice crops are severely infested with weeds and can reduce the grain yields by 16-48% for *aman* rice (IRRI, 1998). Therefore, weed management is an important issue to obtain higher grain yield and better economic return. Weeding in Bangladesh commonly done by manually. In the large scale rice farming, herbicide based weed management has become viable option high costs of labor (Anwar *et al.*, 2012; Singh *et al.*, 2006). Although herbicides are more reliable tools to manage weeds but sole dependence on herbicide may develop resistant biotypes and negative impacts on environment (Fischer *et al.*, 2000). Therefore, effective weed management needs an integrated approach such as appropriate land preparation, use weed seed free tillage instruments, vigorous cultivars, planting density, row spacing, water management, fertilizer management, manual or mechanical weeding and herbicides (Chauhan *et al.*, 2015). Nitrogen is a key nutrient which regulates the growth and development of plants and plays a significant role in the competitive balance between weeds and crops (Raun and Johnson, 1999). Therefore, this study was undertaken to investigate the effect of sources of nitrogen fertilizer and weed management options on the crop and weed growth and crop yield of transplanted *aman* rice.

## Materials and Methods

The experiment was conducted at the agronomy field, Bangladesh Agricultural University, Mymensingh, during the periods from July to December 2013. The experimental field was located at 75 24' N, 50 90' E and altitude of 18 m above the mean of sea level. The experimental site belongs to Agro-ecological Zone 9 of Old Brahmaputra Floodplain. The land was medium high and well drained, the soil was silty loam and low fertility level. The pH value of the soil was 6.7 and average organic matter content 1%. The experimental area was characterized by high temperature (average mean maximum temperature 35°C), high humidity and heavy precipitation with occasional gusty winds in Kharif season (April to October) and scanty rainfall associated with moderately low temperature during the Rabi season (November to March). Historically the experiment site is under rice-fallow-rice cropping system. The experiment consists of four nitrogen sources [100% cowdung (10 t ha<sup>-1</sup>), 100% prilled urea (220 kg ha<sup>-1</sup>), 100% urea super granule (65 kg ha<sup>-1</sup>), and 50% cowdung (5 t ha<sup>-1</sup>) + 50% prilled urea (110 kg ha<sup>-1</sup>)] as main plot treatments and four weed management options [weedy, weed-free, herbicide (oxadiargyl 80 g ai ha<sup>-1</sup>), herbicide (oxadiargyl 80 g ai ha<sup>-1</sup>) followed by one hand weeding (1 HW at 21 days after transplanting (DAT))] as sub-plot treatments. The experiment included in a split-plot design with three replications.

Full dose of TSP, MOP, gypsum, and zinc sulphate were applied at the rate of 15, 48, 12, and 2.2 kg ha<sup>-1</sup> of P, K, S, and Zn, respectively. Cowdung was applied according to treatment and leveling only those plots which received cowdung. Thirty-five-day aged nursery seedling of var. BRRI dhan49 was transplanted on 27 July 2013 using 20cm x 15cm and three seedlings hill<sup>-1</sup>. Prilled urea was applied three equal splits at 15, 35 and 55 DAT. Urea super granules was manually dibbling, one granules in the middle of four hills at 7 DAT. Experiment plots irrigated individually and kept continuous standing water up to 10 days before harvest. Disease and insect management were need based. The plots which received herbicides, applied at 4 DAT. One manual weeding plots were weeding at 21 DAT. Weedy plots allowed season long weed infestation and weed-free plots were kept completely weed-free by 4 times manual weeding.

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Plant height was measured at 35 DAT and at flowering from randomly selected 20 hills. Rice tiller was counted from fixed 8 hills which covered 0.5 m<sup>2</sup> areas. To evaluate the weed management options on weed groups (i.e., grass, broadleaf, and sedge), weed biomass was measured at 35 DAT and flowering from two randomly selected quadrates of 40 cm x 40 cm. Weeds were separated by group, and their biomass was measured after oven drying the samples at 70 °C for 72 h. SPAD value was measured using SPAD meter from randomly selected 10 hills. One top most fully expanded leaf was selected from each hill and measured from tip, middle and base of the leaf. When 80-90% of the grains became golden yellow, the crop was considered to be matured. Grain yield was converted to t ha<sup>1</sup> at 14% moisture content. Data were analyzed using ANOVA to evaluate differences between treatments and the means were separated using least significant differences (LSD) at the 5% level of significance (Crop Stat 7.2; International Rice Research Institute, Philippines).

## Results and Discussion

### Plant height

Plant height did not influence by the interaction of nitrogen sources and weed management options, however, influenced by their individual effect (Figure 1). The highest plant height (53.8 cm) was recorded when plots received 50% cowdung + 50% prilled urea AT 35 DAT. Plot received with 100% prilled urea had statistically similar plant height to 50% cowdung + 50% prilled urea.

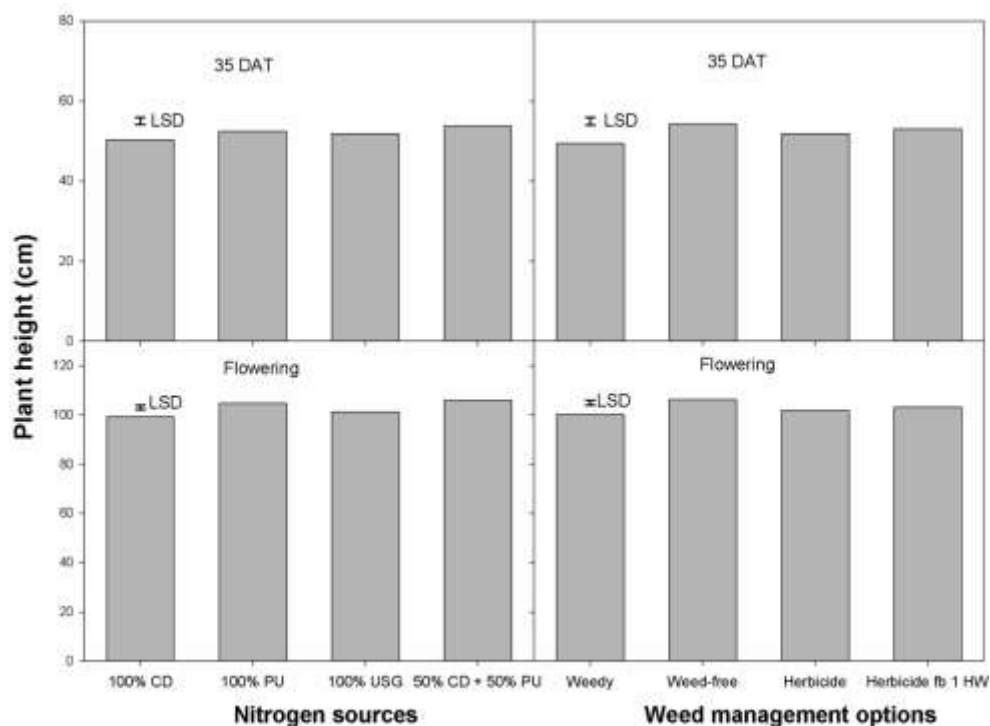


Fig.1. Effect of nitrogen sources and weed management options on plant height at 35 DAT and at flowering. CD (Cowdung), PU ( Prilled Urea), USG, (Urea Super Granule). Vertical bars indicate LSD at 5% level of significant.

The lowest plant height (50.3 cm) was recorded from plots received 100% cowdung. in case of weed management options, the maximum plant height (54.2 cm) was recorded from the weed-free plots followed by one hand weeding while lower (49.4 cm) plant height in weed control (Figure 1). At flowering, plant height was maintained a similar trend to 35 DAT.

### Rice tiller

Tiller density significantly influenced by the interaction of nitrogen sources and weed management options (Figure 2). Tiller density at 35 DAT had higher than at flowering and it was due to some tiller mortality after panicle formation. Similar results were reported by Hasanuzzaman *et al.*, 2009; Sudhir-Yadav *et al.*, 2011. Tiller density was higher when plots received nitrogen source of 50% cowdung + 50% prilled urea with season long weed-free. The 100% prilled urea had significantly similar tiller density to 50% cowdung + 50% prilled urea treatment. The plots received nitrogen source 100% cowdung had always lower tiller density than the nitrogen sources of 50% cowdung + 50% prilled urea and 100% prilled urea, however, almost similar to 100% USG. The lowest panicle density was recorded in season long weedy treatment. The plots which received only herbicide had significantly higher tillers than the weedy treatment.

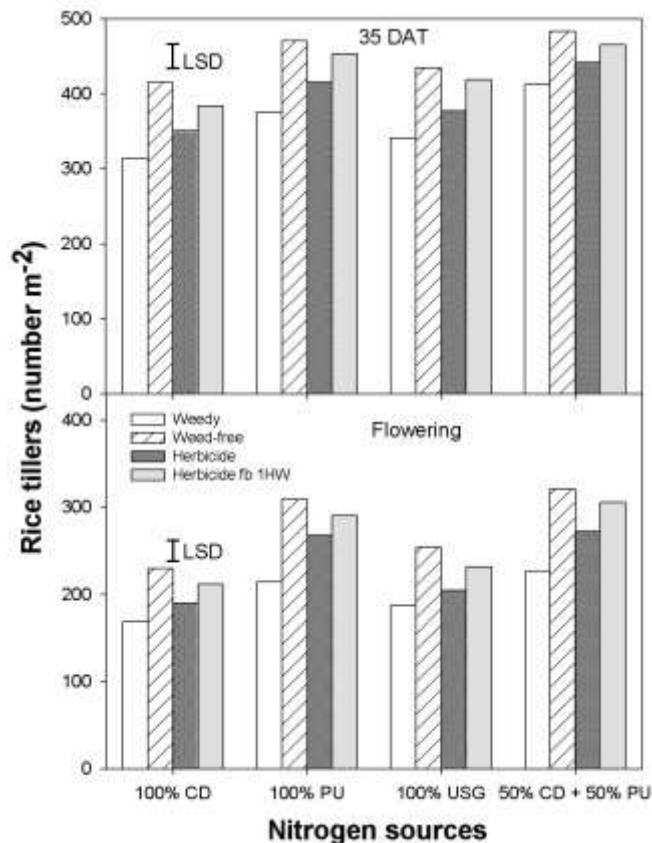


Fig. 2. Effect of nitrogen sources and weed management options on rice tiller (number m<sup>-2</sup>) at 35 DAT and at flowering. CD (Cowdung), PU (prilled urea), USG (Urea Super Granule). Vertical bars indicate LSD at 5% level of significant.

### Rice biomass

There was an interaction between nitrogen sources and weed management options on rice biomass (Figure 3). Irrespective of the nitrogen sources, weed-free treatment had always higher rice biomass than any other weed management options. Across the nitrogen sources, herbicide followed by 1HW treatment had 6-13% lower rice biomass than the weed-free treatment, however, 4-19% higher than the treatment which received only herbicide. Season long weedy treatment had always lower rice biomass. In case of nitrogen sources, 50% cowdung + 50% prilled urea had always higher rice biomass. At 35 DAT, nitrogen source of 100% prilled urea had similar rice biomass to 50% cowdung + 50% prilled urea, however, at flowering it was lower. Irrespective of the weed control options, 100% USG had significantly lower rice biomass than the 50% cowdung + 50% prilled urea and 100% prilled urea, however, significantly higher than the nitrogen source 100% cowdung.

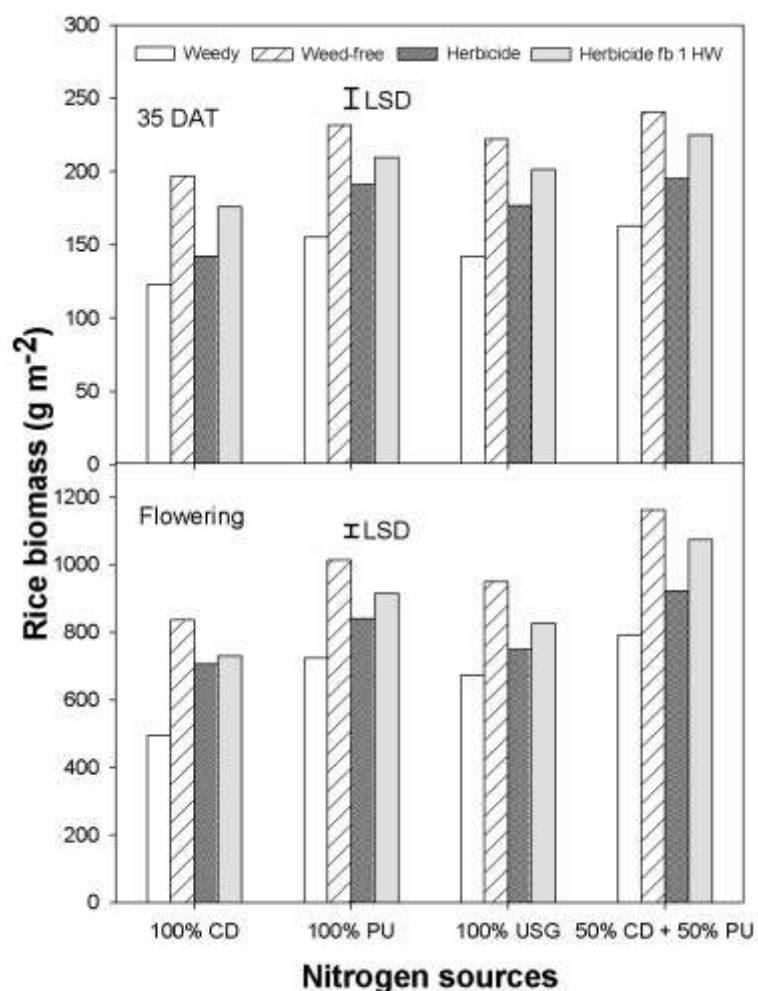


Fig. 3. Effect of nitrogen sources and weed management options on rice biomass ( $\text{g m}^{-2}$ ) at 35 DAT and at flowering. CD (Cowdung), PU (prilled urea), USG (Urea Super Granule). Vertical bars indicate LSD at 5% level of significant.

**SPAD value**

SPAD value was significantly influenced by the interaction between N sources and weed management options (Figure 4). Considered with the N sources, at 35 DAT, the highest SPAD value was recorded when plots received 50% cowdung + 50% prilled urea. Plots received with 100% prilled urea had statistically similar SPAD value to 50% cowdung + 50% prilled urea. Plots received with 100% cowdung produced the lowest SPAD value. In weed management options, weed-free treatment had always higher SPAD value. The treatment herbicide followed by 1 HW had significantly similar SPAD value to weed-free treatment. The lowest SPAD value was recorded in weedy treatment. Similar to the result of 35 DAT, at flowering, SPAD value almost maintain similar trend. When rice plants had more competition with weeds, SPAD values decreased and it was due to both weed and rice plants shared the available resources (Awan *et al.*, 2014).

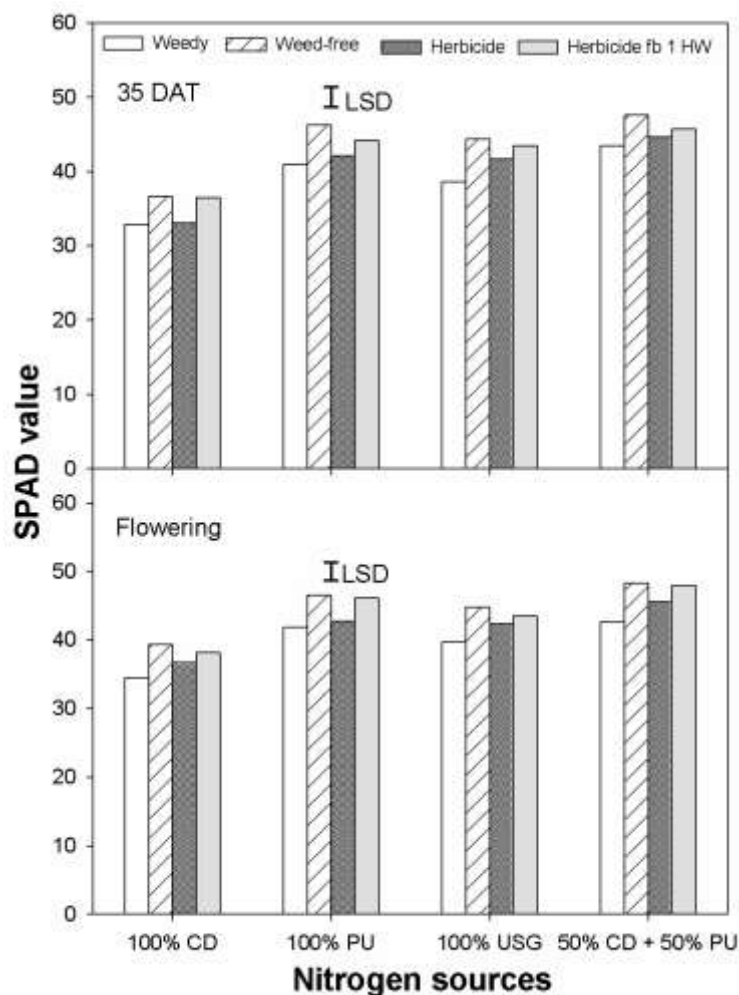


Fig. 4. Effect of nitrogen sources and weed management options on SPAD value at 35 DAT and at flowering. CD ( Cowdung); PU ( prilled urea),USG ( uUrea Super Granule). Vertical bars indicate LSD at 5% level of significant.

### Weed biomass

The common weed species found in the experiment field were comprised of grasses (*Cynodon dactylon*, *Echinochloa crusgalli*, *Leersia hexandra*, *Paspalum scrobiculatum*) broadleaf (*Marselia quadrifolia*, *Monochoria vaginalis*, *Pistia stratiotes*) and sedges (*Cyperus iria*, *Fimbristylis miliacea*, *Scirpus juncooides*). Regarding the N sources, the highest total weed biomass was recorded when plots received 100% prilled urea (Figure 5).

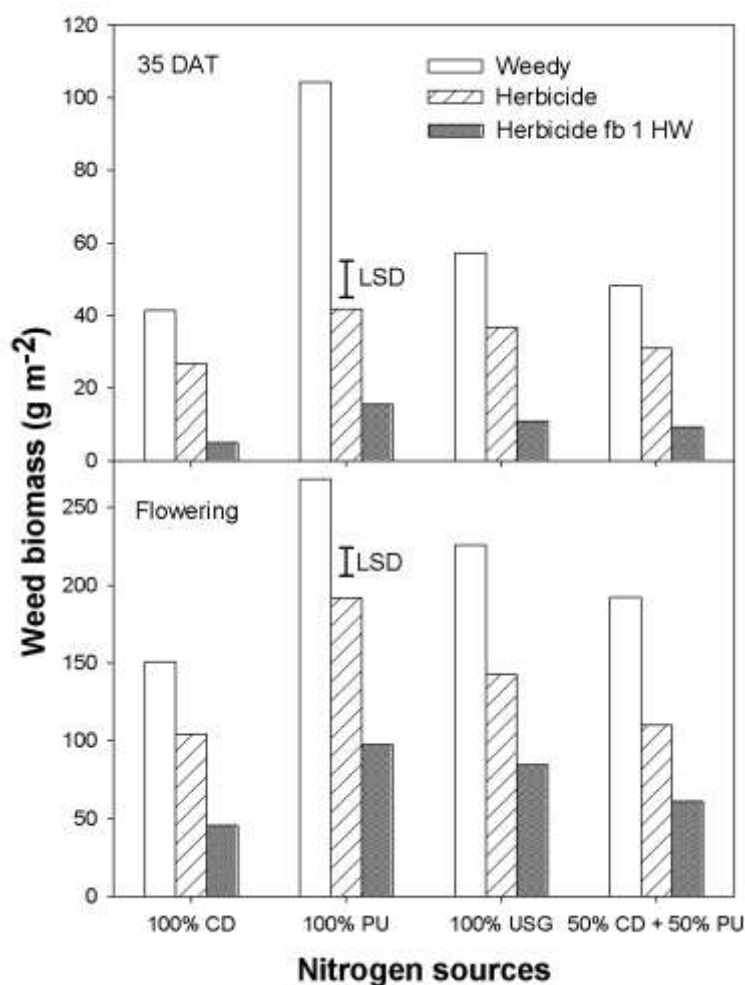


Fig. 5. Effect of nitrogen sources and weed management options on total weed biomass (gm<sup>-2</sup>) at 35 D AT and at flowering. CD (Cowdung), PU (Prilled Urea), USG ( Urea Super Granule). Vertical bars indicate LSD at 5% level of significant.

Irrespective of the weed control options, at 35 DAT, the nitrogen sources 100% USG, 50% cowdung + 50% prilled urea, and 100% cowdung had 54, 46 and 35% lower weed biomass, respectively, compared with 100% prilled urea. These values were 46, 35 and 19% at flowering. The dominant weed group found in the experiment was grass weed (Figure 6).

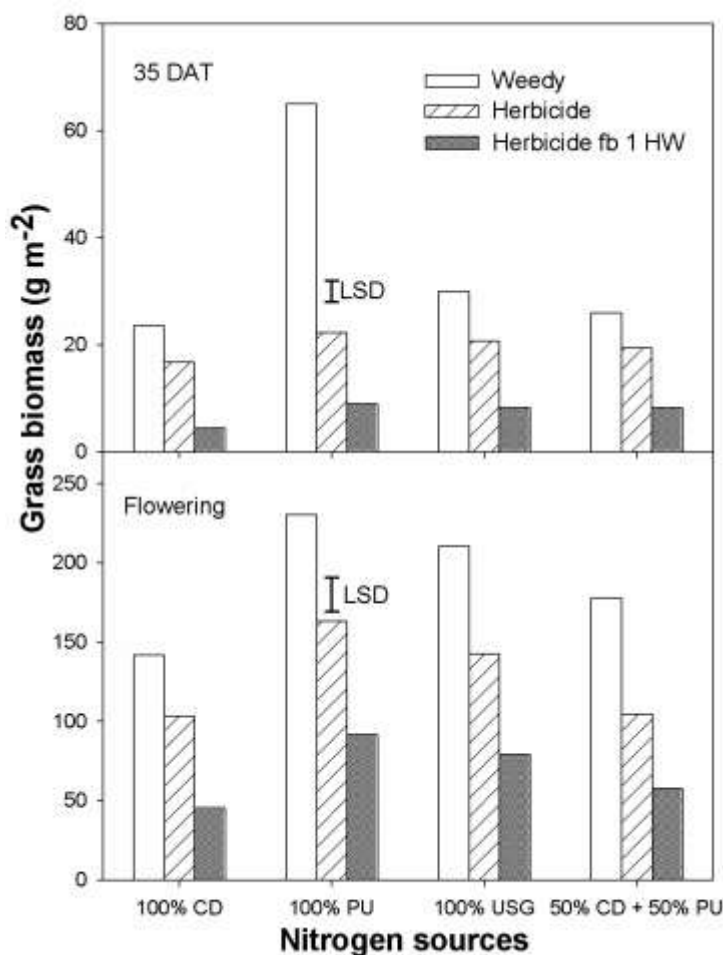


Fig. 6. Effect of nitrogen sources and weed management options on grass weed biomass ( $\text{g m}^{-2}$ ) at 35 DAT and at flowering. CD (Cowdung), PU ( Prilled Urea), USG (Urea Super Granule). Vertical bars indicate LSD at 5% level of significant.

At 35 DAT, the highest grass weed biomass was found in nitrogen sources 100% prilled urea treatment. In weed control options, the nitrogen sources 100% USG, 50% cowdung + 50% prilled urea, and 100% cowdung had 53, 44 and 39% less grass weed biomass, respectively, compared with 100% prilled urea treatment. Considered with the broadleaf weed, at 35 DAT, the season long weedy treatment of all nitrogen sources had similar biomass, however, at flowering 100% pill urea had significantly higher biomass than other nitrogen sources (Figure 7). Considered with the sedge weed, the highest weed biomass was recorded when plots received nitrogen source of 100% prilled urea and the lowest in 100% cowdung (Figure 8). When plots received weed control option herbicide followed by 1 HW, sedge biomass was almost zero. Similar effect at flowering stage which might be due to the shedding effect of rice canopy. As such prilled urea influenced weed growth better than other sources. The results were consistent with the previous study. ( Blackshaw, 2005; Kirkland and Beckie, 1998).



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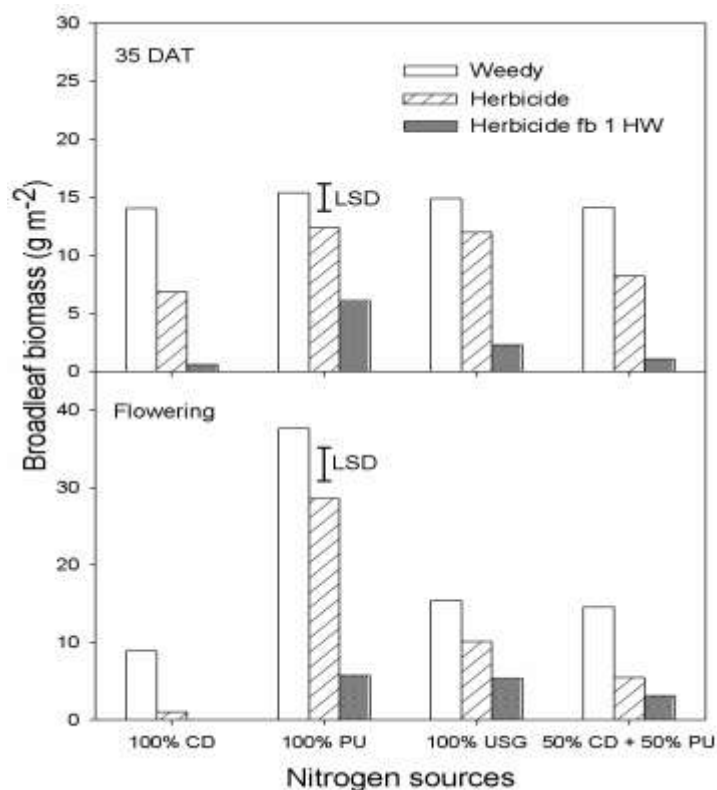


Fig. 7. Effect of nitrogen sources and weed management options on broadleaf weed biomass (gm<sup>-2</sup>) at 35 DAT and at flowering. CD (Cowdung), PU (Prilled Urea), USG (Urea Super Granule). Vertical bars indicate LSD at 5% level of significant.

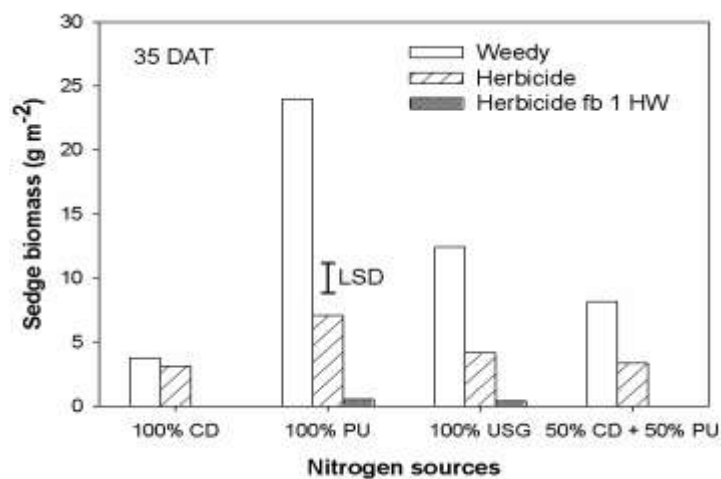


Fig. 8. Effect of nitrogen sources and weed management options on sedges biomass (gm<sup>-2</sup>) at 35 DAT and at flowering. CD (Cowdung) PU (Prilled Urea), USG (Urea Super Granule). Vertical bars indicate LSD at 5% level of significant.

### Yield and yield components

There was a significant interaction between N sources and weed management options on panicles number (Figure 9). In N sources, panicle number was always higher in weed-free by manual weeding. The weed management option herbicide followed by 1HW had significantly similar panicle number to weed-free treatment. Only herbicide treatment had similar panicle number to herbicide followed by 1HW. In weed management options, the nitrogen source of 50% cowdung + 50% prilled urea had higher panicle number which was significantly similar to nitrogen source 100% prilled urea. Compared with 50% cowdung + 50% prilled urea treatment, the nitrogen sources 100% USG and 100% cowdung had 10 and 19% fewer panicle number, respectively. Effect of nitrogen sources and weed control option on florets panicle<sup>-1</sup> was found that florets panicle<sup>-1</sup> maintained almost similar trend to panicle number (Figure 10).

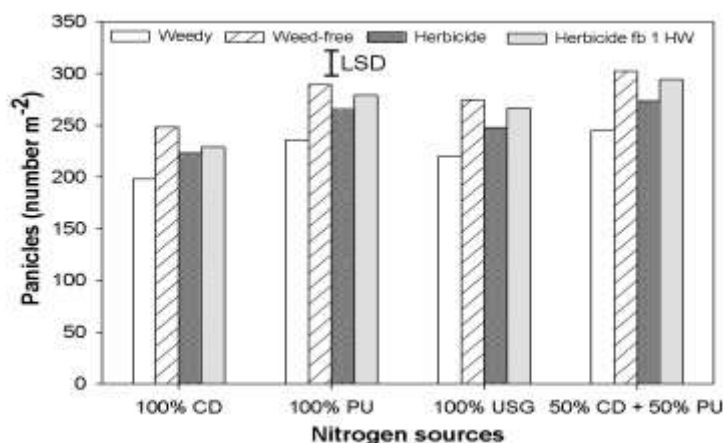


Fig. 9. Effect of nitrogen sources and weed management options on panicles (number m<sup>-2</sup>) at physiological maturity. CD (Cowdung); PU (Prilled Urea), USG (Urea Super Granule). Vertical bars indicate LSD at 5% level of significant.

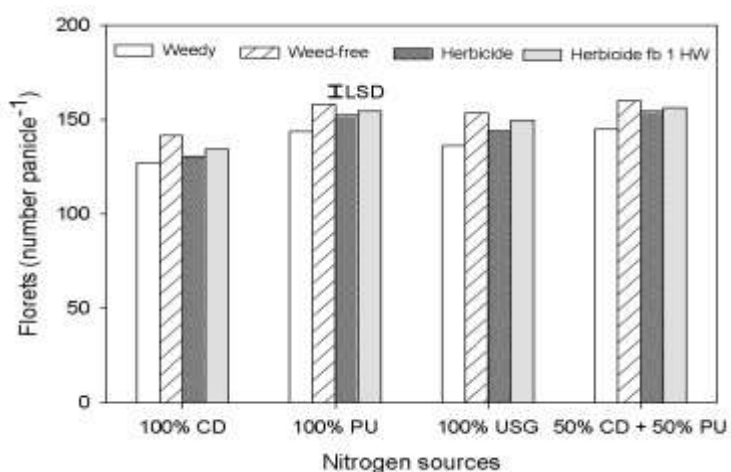


Fig. 10. Effect of nitrogen sources and weed management options on floret (numbers panicle<sup>-2</sup>) at physiological maturity. CD (Cowdung), PU (Prilled Urea), USG (Urea Super Granule). Vertical bars indicate LSD at 5% level of significant.

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Grain and straw yields were also influenced by the interaction of nitrogen sources and weed management option. Irrespective of the weed management options, nitrogen source 50% cowdung + 50% prilled urea had always higher grain and straw yield (Figure 11 and 12). Although 100% prilled urea had significantly similar grain and straw yield to 50% cowdung + 50% prilled urea, however, across the weed control options 100% USG and 100% cowdung had 15 and 27% lower grain yield and 9 and 20% lower straw yield, respectively. In nitrogen sources, the weed-free treatment had always higher grain and straw yield. Compared with weed-free treatment, the plots which received only herbicide had 20 and 18% lower grain and straw yield, respectively.

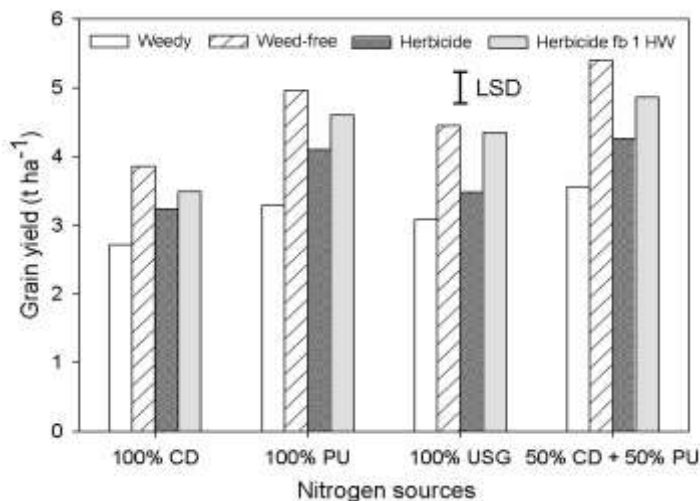


Fig. 11. Effect of nitrogen sources and weed management options rice grain yield (t ha<sup>-1</sup>). CD (cowdung); PU (Prilled urea), USG (Urea Super Granule). Vertical bars indicate LSD at 5% level of significant.

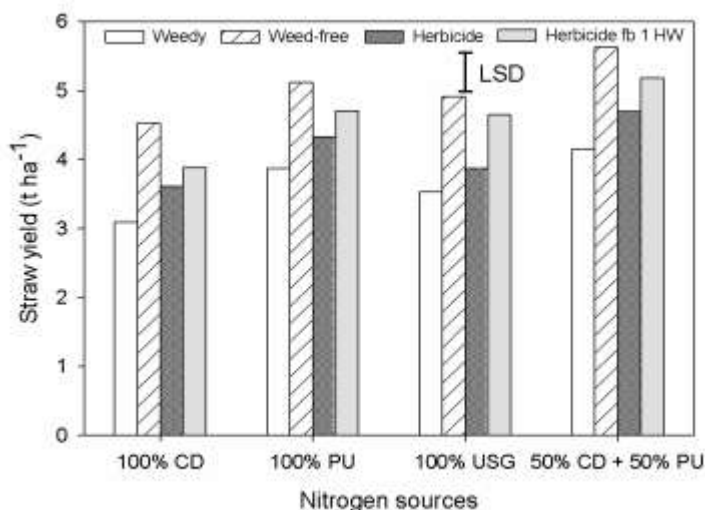


Fig. 12. Effect of nitrogen sources and weed management options on rice straw yield (t ha<sup>-1</sup>). CD (Cowdung), PU (Prilled Urea), USG (Urea Super Granule). Vertical bars indicate LSD at 5% level of significant.

Use of 100% prilled urea is better than the 100% USG in terms of rice yield, however, prilled urea influence more weed growth than USG. So, the best N source was 50% cowdung + 50% prilled urea. Although 100% prilled urea had similar yield to 50% cowdung + 50% prilled but 100% prilled urea stimulates weed growth. Pre-emergence herbicide followed by 1 HW significantly controlled weed and found similar yield to weed free. Though maximum yield was obtained from weed free plot but it was not feasible due to high cost involvement of manual weeding. Therefore, the best weed management option is pre-emergence herbicide followed by one hand weeding.

## Conclusion

Pre-emergence herbicides followed by on hand weeding (21DAS) is better weed management option for transplanted aman rice.

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