*Indian J. Weed Sci.* **43** (1 & 2) : 61-66 (2011)

# Effect of Brown Manuring on Grain Yield and Nutrient Use Efficiency in Dry Direct Seeded Kharif Rice (*Oryza sativa* L.)

**Swapan Kumar Maity and P. K. Mukherjee**
Department of Agronomy
Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar-736 165 (West Bengal), India

## ABSTRACT

A field study was carried out during **kharif** seasons of 2006 and 2007 at university research farm for generating information on weed flora and to work out integrated weed management practices with its economics in dry direct seeded **kharif** rice. Among the weed flora, emergence of grasses like *Cynodon dactylon* and *Echinochloa colona,* sedges like *Cyperus rotundus, Cyperus iria* and *Fimbristylis miliacea* and broad-leaved weeds like *Ludwigia parviflora, Ageratum conyzoides, Spilanthes paniculata, Eclipta alba* and *Enhydra fluctuans* were recorded during experimentation. Among the integrated weed management practices, butachlor 1.5 kg/ha as pre-plant surface application followed by practices of brown manuring and post-emergence application of 2,4-D 0.50 kg/ha at 40 days after sowing recorded highest grain yield (3.0 and 3.88 t/ha), highest net returns (Rs.11889 and 19029/ha) and benefit : cost ratio (0.74 and 1.19) during both the years of investigation. The grain yield was statistically at par with the grain yield (3.14 and 3.98 t/ha) obtained from season long weed free condition. There has been considerable improvement in nutrient use efficiency due to adoption of weed control practices coupled with nitrogen management and among the integrated weed management practices highest nutrient use efficiency of N (50.00 and 64.67 kg grain yield/kg nutrient applied), P (229.36 and 296.64 kg grain yield/kg nutrient applied) and K (90.36 and 116.87 kg grain yield/kg nutrient applied) were highest with butachlor 1.5 kg/ha + brown manuring + 2,4-D 0.5 kg/ha in both the years.

**Key words :** Integrated weed management, direct seeded rice, weed flora, nutrient use efficiency

## INTRODUCTION

Rice (*Oryza sativa* L.) is cultivated during **kharif** season as rainfed crop under transplanted condition in *terai* agro-climatic region of West Bengal. Seed bed preparation, puddling and transplanting operation usually incur huge labour cost. Most of the farmers in this region are marginal in nature and unable to bear the cost in carrying out these operations. In addition to this long turn-around time coupled with unpredictable monsoon results in delayed sowing of succeeding crops. Direct seeding with pre-germinated rice seed in unpuddled condition could be an effective option to combat these problems if the weeds are controlled effectively as it becomes a major constraint in direct-seeded rice ecosystem. Moody (1980) reported that the extent of yield reduction due to unchecked weed growth has been estimated on account of 20-25% for transplanted rice and 40-50% for direct-seeded rice. Rice grain production in India suffers yearly loss of 15 million tonnes due to weed competition (Chatterjee and Maity, 1981). Sipaseuth *et al.* (2000) reported that when weed control was optimum and crop establishment was good, yields of direct-seeded rice could equal to those of transplanted crops. Fractional application of nitrogen in right amount and proportion coupled with weed control practices facilitates higher absorption of applied nitrogen and thus increasing efficiency of fertilizer nitrogen (Amarjit *et al.,* 2006). Therefore, present study was conducted to find out integrated weed management practices in dry direct-seeded **kharif** rice.

## MATERIALS AND METHODS

A field experiment was conducted during **kharif** seasons of 2006 and 2007 at Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal. The soil of experimental field was sandy to sandy loam in texture, medium in fertility with pH 5.5. Pre-germinated seed of rice cv. M. T. U. 7029 (40 kg/ha) was sown in 15 cm spaced rows on 12 July 2006 and 26 June 2007 with a plot size of 8 x 4 m. Recommended dose of fertilizers was 60 : 30 : 40 (N, $P_2O_5$ and $K_2O$). Nitrogenous fertilizer was applied in four splits [¼ at basal, ¼ at 25 days after sowing (DAS), ¼ at 45 DAS and ¼ at 60 DAS] in all the treatments except under farmers' practice where application was made in three splits (1/3 at 15 DAS, 1/3 at 30 DAS and 1/3 at 60 DAS). Experiment with 11 treatments viz., butachlor 1.5 kg/ha used as pre-plant surface application + hoeing at 30 DAS + 2,4-D 0.5 kg/ha used as post-emergence at 40 DAS, pretilachlor 0.75 kg/ha as pre-plant surface application + hoeing at 30 DAS +2,4-D 0.5 kg/ha as post-emergence at 40 DAS, pendimethalin 0.6 kg/ha as pre-plant surface application +hoeing at 30 DAS+2,4-D 0.5 kg/ha as post-emergence at 40 DAS, benthiocarb 1.5 kg/ha as pre-plant surface application+hoeing at 30 DAS+2,4-D 0.5 kg/ha as post-emergence at 40 DAS, butachlor 1.5 kg/ha as pre-plant surface application+brown manuring+2,4-D 0.5 kg/ha as post-emergence at 40 DAS, pretilachlor 0.75 kg/ha as pre-plant surface application+brown manuring+2,4-D 0.5 kg/ha as post-emergence at 40 DAS, pendimethalin 0.6 kg/ha as pre-plant surface application+brown manuring+2,4-D 0.5 kg/ha as post-emergence at 40 DAS, benthiocarb 1.5 kg/ha as pre-plant surface application+brown manuring+2,4-D 0.5 kg/ha as post-emergence at 40 DAS, farmers' practice consisted of three hand weedings at 15, 30 and 50 DAS, complete weed free situation and season long weedy condition were replicated thrice in a randomized block design.

*Sesbania rostrata* with the seed rate of 50 kg/ha was grown for brown manuring at inter row spaces of 30 cm between paired row rice having the spacing of 15 cm. *S. rostrata* was then killed by the application of 2,4-D 0.5 kg/ha at 25 DAS followed by its mulching with the help of rotary paddy weeder. Weed dry weight was recorded using 50 x 50 cm quadrate from all the plots at 60 DAS. Data on weed dry weight (g/m$^2$) were subjected to square-root ($\sqrt{X+0.5}$) transformation before statistical analysis. The weed control efficiency (WCE), weed index (WI) and nutrient use efficiency (NUE) were calculated by using following formulae :

$$\text{WCE (\%)} = \frac{\text{Dry weight of weed in control plot} - \text{Dry weight of weed in treated plot}}{\text{Dry weight of weed in control plot}} \times 100$$

$$\text{WI (\%)} = \frac{\text{Grain yield in complete weed free plot} - \text{Grain yield in treated plot}}{\text{Grain yield in complete weed free plot}} \times 100$$

$$\text{NUE} = \frac{\text{Grain yield (kg)}}{\text{Amount of nutrient applied (kg)}} \text{(kg grain yield/kg nutrient applied)}$$

Distribution of rainfall was erratic during monsoon period of 2006 leading to occurrence of drought especially at the initial stage of rice crop, however, it was well distributed in the year 2007 (Fig. 1).

## RESULTS AND DISCUSSION

### Effect on Weeds

Among the weed flora, emergence of grasses like *Cynodon dactylon* and *Echinochloa colona,* sedges like *Cyperus rotundus, Cyperus iria* and *Fimbristylis miliacea* and broad-leaved weeds like *Ludwigia parviflora, Ageratum conyzoides, Spilanthes paniculata, Enhydra fluctuans* and *Eclipta alba* were recorded during experimentation. The similar finding was also reported by Choubey *et al.* (1998). Grasses and sedges especially *C. rotundus* appeared during initial growth stages, while broad-leaved weed specially *L. parviflora* and sedges *C. iria* and *F. miliacea* emerged after that. Emergence of these weeds was observed during 15 to 20 DAS and thereafter they continuously emerged throughout the growth stages. Other broad-leaved weeds like *A. conyzoides, S. paniculata* and *E. alba* appeared during later stages of crop growth. Among the broad-leaved weeds, *S. paniculata* appeared during first year, whereas *E. fluctuans* appeared during second year of experimentation.

Results obtained from the experiment revealed that among the herbicides+cultural methods of weed control, combination of butachlor + brown manuring + 2,4-D application at 40 DAS recorded lowest weed dry weight at 60 DAS leading to highest value of weed control efficiency of 86.0% in 2006 and 88.15% in 2007

Table 1. Effect of treatments on dry weight of grasses, sedges, broadleaf weeds, weed control efficiency and weed index in dry direct seeded **kharif** rice

| Treatments | Dry weight of grasses at 60 DAS (g/m$^2$) | | Dry weight of sedges at 60 DAS (g/m$^2$) | | Dry weight of broadleaf weeds at 60 DAS (g/m$^2$) | | Weed control efficiency at 60 DAS (%) | | Weed index (%) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2006 | 2007 | 2006 | 2007 | 2006 | 2007 | 2006 | 2007 | 2006 | 2007 |
| Butachlor+brown manuring+2, 4-D | 3.07<br>(8.94) | 2.72<br>(6.88) | 1.91<br>(3.16) | 2.04<br>(3.67) | 1.28<br>(1.14) | 1.10<br>(0.72) | 86.00 | 88.15 | 4.46 | 2.15 |
| Pretilachlor+brown manuring+2, 4-D | 3.58<br>(12.34) | 3.27<br>(10.22) | 2.21<br>(4.37) | 2.32<br>(4.88) | 1.41<br>(1.50) | 1.23<br>(1.02) | 80.74 | 83.05 | 18.15 | 7.03 |
| Pendimethalin+brown manuring+2, 4-D | 3.96<br>(15.19) | 3.68<br>(13.08) | 2.63<br>(6.44) | 2.73<br>(6.94) | 1.54<br>(1.87) | 1.36<br>(1.36) | 75.16 | 77.52 | 20.06 | 19.85 |
| Benthiocarb+brown manuring+2, 4-D | 4.29<br>(17.95) | 4.04<br>(15.86) | 2.81<br>(7.42) | 2.93<br>(8.07) | 1.63<br>(2.14) | 1.46<br>(1.63) | 70.90 | 73.12 | 31.53 | 21.86 |
| Butachlor+hoeing+2, 4-D | 3.78<br>(13.83) | 3.49<br>(11.69) | 2.44<br>(5.45) | 2.54<br>(5.95) | 1.54<br>(1.88) | 1.36<br>(1.35) | 77.62 | 80.04 | 33.12 | 18.84 |
| Pretilachlor+hoeing+2, 4-D | 4.23<br>(17.43) | 3.97<br>(15.29) | 2.76<br>(7.14) | 2.91<br>(7.97) | 1.59<br>(2.04) | 1.42<br>(1.53) | 71.85 | 73.93 | 35.67 | 20.85 |
| Pendimethalin+hoeing+2, 4-D | 4.81<br>(22.67) | 4.52<br>(19.93) | 3.02<br>(8.68) | 3.20<br>(9.73) | 1.71<br>(2.42) | 1.55<br>(1.90) | 64.64 | 66.81 | 39.17 | 27.64 |
| Benthiocarb+hoeing+2, 4-D | 5.08<br>(25.34) | 4.79<br>(22.48) | 3.05<br>(8.86) | 3.24<br>(9.99) | 1.80<br>(2.73) | 1.64<br>(2.20) | 61.29 | 63.53 | 39.81 | 29.90 |
| Farmer's practice | 1.44<br>(1.60) | 1.43<br>(1.55) | 1.14<br>(0.80) | 1.11<br>(0.73) | 0.97<br>0.47 | 0.96<br>0.41 | 97.00 | 97.15 | 3.50 | 2.01 |
| Complete weed free situation | 0.71<br>(0.00) | 0.71<br>(0.00) | 0.71<br>(0.00) | 0.71<br>(0.00) | 0.71<br>(0.00) | 0.71<br>(0.00) | 100.00 | 100.00 | 0.00 | 0.00 |
| Season long weedy condition | 5.08<br>(25.37) | 4.98<br>(24.33) | 3.14<br>(9.35) | 3.21<br>(9.82) | 7.77<br>(59.84) | 7.97<br>(62.96) | 0.00 | 0.00 | 83.75 | 71.10 |
| LSD (P=0.05) | 0.22 | 0.15 | 0.19 | 0.13 | 0.08 | 0.07 | | | | |
| S. Em± | 0.10 | 0.07 | 0.09 | 0.06 | 0.04 | 0.03 | | | | |

Figures in parentheses are original values. DAS–Days after sowing.

at 60 DAS (Table 1). It was closely followed by pretilachlor + brown manuring + 2,4-D at 40 DAS and butachlor + hoeing + 2,4-D at 40 DAS (Table 1). Among the integrated weed management practices, butachlor+brown manuring + 2,4-D recorded lowest weed index value of 4.5 and 2.5% in 2006 and 2007, respectively (Table 1). Highest value of weed control efficiency and lowest value of weed index of butachlor + brown manuring+2,4-D reflected its selectivity and higher efficacy in controlling weeds. Butachlor + brown manuring+2,4-D was able to reduce weed pressure as brown manuring acted as a cover crop in suppressing weed growth effectively at the initial growth stage. Angadi *et al*. (1993), Sharma and Ghosh (2000) and Yadav (2004) also reported similar results.

**Effect on Crop Yield**

The highest grain (3.0 and 3.88 t/ha) and straw (5.42 and 5.96 t/ha) yield was recorded with butachlor 1.5 kg/ha + brown manuring + 2,4-D 0.5 kg/ha which was statistically at par with the grain (3.14 and 3.98 t/ha) and straw (5.33 and 6.04 t/ha) yield obtained from complete weed free condition during both the years of experimentation. This was due to high weed control efficiency of the treatment (butachlor 1.5 kg/ha + brown manuring+2,4-D 0.5 kg/ha) throughout the crop season without causing any crop phytotoxicity. It was closely followed by pretilachlor 0.75 kg/ha+brown manuring+2,4-D 0.5 kg/ha (2.57 and 3.70 t/ha) during 2006 and these were statistically at par in the second year. Among the integrated weed management practices comprising herbicides+mechanical methods of weed control, butachlor 1.5 kg/ha+hoeing at 30 DAS+2,4-D 0.5 kg/ha recorded highest grain (2.10 and 3.23 t/ha) and straw yield (4.67 and 5.52 t/ha) than pretilachlor 0.75 kg/ha+hoeing at 30 DAS+2,4-D 0.5 kg/ha, pendimethalin 0.6 kg/ha+hoeing at 30 DAS + 2,4-D 0.5 kg/ha and benthiocarb 1.5 kg/ha+hoeing at 30 DAS + 2,4-D 0.5 kg/ha during both the years (Table 2). The grain yield was lower in the first year than that in the second year of experimentation because of erratic rainfall pattern of monsoon in the first year resulting in occurrence of drought especially during active crop growth stage. However, rainfall pattern of monsoon in the second year was well distributed (Fig. 1) during growth stages of rice resulting in better crop performance.

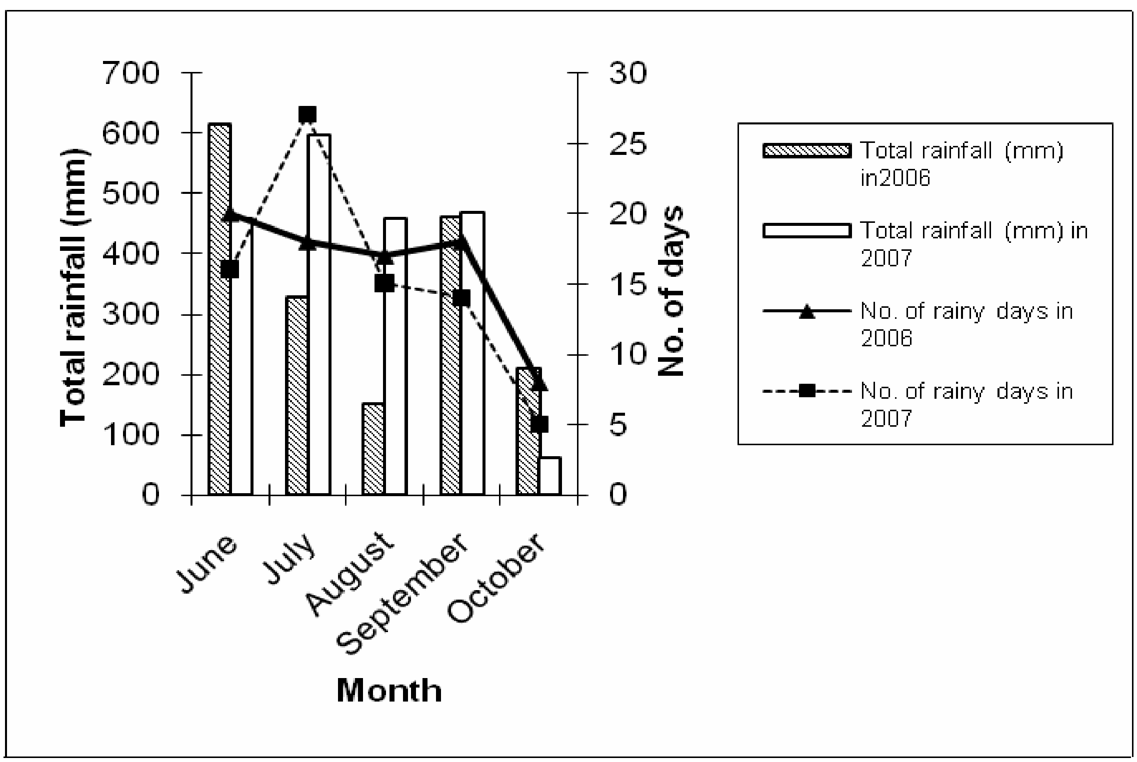


Fig. 1. Total rainfall (mm) and number of rainy days of 2006 and 2007 during monsoon.

Table 2. Effect of treatments on grain yield, straw yield, nutrient use efficiency, net return and benefit : cost ratio of dry direct seeded **kharif** rice

| Treatments | Grain yield (t/ha) | | Straw yield (t/ha) | | Nutrient use efficiency (kg grain yield/kg nutrient applied) | | | | | | Net return (Rs./ha) | | Benefit : cost ratio | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | N | | P | | K | | | | | |
| | 2006 | 2007 | 2006 | 2007 | 2006 | 2007 | 2006 | 2007 | 2006 | 2007 | 2006 | 2007 | 2006 | 2007 |
| Butachlor+brown manuring+2, 4-D | 3.00 | 3.88 | 5.42 | 5.96 | 50.00 | 64.67 | 229.36 | 296.64 | 90.36 | 116.87 | 11889 | 19029 | 0.74 | 1.19 |
| Pretilachlor+brown manuring+2, 4-D | 2.57 | 3.70 | 5.31 | 5.89 | 42.83 | 61.67 | 196.48 | 282.87 | 77.41 | 111.45 | 8374 | 17429 | 0.52 | 1.08 |
| Pendimethalin+brown manuring+2, 4-D | 2.51 | 3.19 | 5.22 | 5.71 | 41.83 | 53.17 | 191.90 | 243.88 | 75.60 | 96.08 | 7386 | 12976 | 0.44 | 0.78 |
| Benthiocarb+brown manuring+2, 4-D | 2.15 | 3.11 | 5.01 | 5.67 | 35.83 | 51.83 | 164.37 | 237.77 | 64.76 | 93.67 | 4492 | 12352 | 0.27 | 0.74 |
| Butachlor+hoeing+2, 4-D | 2.10 | 3.23 | 4.67 | 5.52 | 35.00 | 53.83 | 160.55 | 246.94 | 63.25 | 97.29 | 5397 | 14722 | 0.36 | 0.98 |
| Pretilachlor+hoeing+2, 4-D | 2.02 | 3.15 | 4.59 | 5.48 | 33.67 | 52.50 | 154.43 | 240.83 | 60.84 | 94.88 | 4537 | 13902 | 0.30 | 0.91 |
| Pendimethalin+hoeing+2, 4-D | 1.91 | 2.88 | 4.58 | 5.43 | 31.83 | 48.00 | 146.02 | 220.18 | 57.53 | 86.75 | 3254 | 11379 | 0.21 | 0.73 |
| Benthiocarb+hoeing+2, 4-D | 1.89 | 2.79 | 4.55 | 5.36 | 31.50 | 46.50 | 144.50 | 213.30 | 56.93 | 84.04 | 3090 | 10650 | 0.20 | 0.68 |
| Farmer's practice | 3.03 | 3.90 | 5.25 | 5.97 | 50.50 | 65.00 | 231.65 | 298.17 | 91.27 | 117.47 | 5738 | 12983 | 0.26 | 0.58 |
| Complete weed free situation | 3.14 | 3.98 | 5.33 | 6.04 | 52.33 | 66.33 | 240.06 | 304.28 | 94.58 | 119.88 | 2888 | 9898 | 0.11 | 0.38 |
| Season long weedy condition | 0.51 | 1.15 | 2.41 | 3.84 | 8.50 | 19.17 | 38.99 | 87.92 | 15.36 | 34.64 | - 6239 | - 9.00 | - 0.50 | 0.00 |
| LSD (P=0.05) | 0.40 | 0.88 | 1.19 | 1.04 | | | | | | | | | | |
| S. Em± | 0.19 | 0.42 | 0.57 | 0.50 | | | | | | | | | | |

Sale price of output (Rs./t) : Rice grain–7500, rice straw–1000; Input price (Rs./kg) : Rice seed–10, Seed of *Sesbania rostrata*–10, Urea–4.78, SSP–3.22, MOP–4.45; Herbicides (Rs./l) : Butachlor–180, pretilachlor–480, pendimethalin–584, benthiocarb–384, 2,4-D sodium salt–220; labour wage–Rs. 75.10/man day.

## Effect on Nutrient Use Efficiency

Nutrient use efficiency was positively influenced by weed management practices coupled with nitrogen management. Among the integrated weed management practices nutrient use efficiency of N (50.00 and 64.67 kg grain yield/kg nutrient applied), P (229.36 and 296.64 kg grain yield/kg nutrient applied) and K (90.36 and 116.87 kg grain yield/kg nutrient applied) was highest under butachlor 1.5 kg/ha+brown manuring+2,4-D 0.5 kg/ha treated plots during both the years of investigation in which nitrogen was applied in four splits. Skipping of basal dose of nitrogen in farmers' practice had considerable effect on nutrient use efficiency of the nutrients. Therefore, adoption of integrated weed management practice coupled with nitrogen management has considerably improved nutrient use efficiency over weedy condition, which in turn, reflected higher response of fertilizer nutrients on crop performance.

## Economics

Among the integrated weed management practices butachlor 1.5 kg/ha + brown manuring + 2, 4-D 0.5 kg/ha registered highest net return (Rs.11889 and 19029/ha) as well as benefit : cost ratio (0.74 and 1.19) during both the years. This might be owing to high weed control efficiency with least man day's engagement and higher grain yield. The lower net return (Rs. 5738 and 12983/ha) and benefit : cost ratio (0.26 and 0.58) in farmers' practice might be due to more man days engaged at 15, 30 and 50 DAS and that in turn considerably increased cost of cultivation (Table 2).

Integrated weed management practices comprising butachlor 1.5 kg/ha as pre-plant surface application + brown manuring + 2,4-D 0.50 kg/ha at 40 DAS could become effective in controlling weeds as well as getting higher yield during **kharif** season in dry direct seeded rice ecosystem under *terai* agro-climatic region of West Bengal. There has been considerable improvement in nutrient use efficiency due to adoption of weed control practices coupled with nitrogen management.

## REFERENCES

Amarjit, S. B., M. Singh, D. Kachroo, B. C. Sharma and D. R. Shrivan. 2006. Efficiency of herbicides in transplanted, medium-duration rice (*Oryza sativa*) under sub-tropical conditions of Jammu. *Ind. J. Agron.* **51** : 128-130.

Angadi, V. V., P. N. Umapathy, G. V. Nayak, V. C. Patil and B. M. Chittapur. 1993. Integrated weed management in direct seeded rainfed rice of Karnataka. Integrated weed management for sustainable agriculture. Proc. Int. Symp. by Ind. Soc. Weed Sci., held at Hisar, India, during 18-20 November, **Vol. III.** pp. 6-9.

Chatterjee, B. N. and S. Maity. 1981. *Principles and Practices of Rice Growing, 2nd edn.* Oxford and IBH Publications, New Delhi. pp. 293.

Choubey, N. K., R. S. Tripathi, B. C. Ghosh, and S. S. Kolhe. 1998. Influence of fertilizer and weed management practices on weed growth and yield of direct-seeded upland rice. *Oryza* **35** : 154-158.

Moody, K. 1980. Weed science research by IRRI and its role in weed science in the Asian region. *Weed Sci.* **28** : 461-463.

Sharma, A. R. and A. Ghosh. 2000. Effect of green manuring with *Sesbania aculeata* and nitrogen fertilization on the performance of direct-seeded flood-prone lowland rice. *Nutrient Cycling in Agro-ecosystems* **57** : 141-153.

Sipaseuth, I. P., P. Siyavong, V. Sihathep, M. Chanphengsay, J. M. Schiller, B. Linquist, S. Fukai, S. Fukai, (ed.) and J. Basnayake. 2000. Agronomic practices for improving yields of rainfed lowland rice in Laos. In : Proc. International Workshop on Increased Lowland Rice Production in the Mekong Region, held during 30 October-2 November at Vientiane (Laos). pp. 31-40.

Yadav, R. L. 2004. Enhancing efficiency of fertilizer N use in rice-wheat systems of Indo-Gangetic Plains by intercropping *Sesbania aculeata* in direct seeded upland rice for green manuring. *Bioresource Technol.* **93** : 213-215