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Bio-efficacy of some non traditional herbicides against weed complex of jute

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The *terai* agro-climatic region of West Bengal has a characteristic of typical subtropical humid climate with the annual rainfall of 3000 mm (Mukherjee *et al.,* 2007). Jute is an important cash crop in this region. However, aggressive growth of weeds comprising of grasses *Cynodon dactylon* (L.) Pers., *Digitaria ciliaris* (Retz.) Koel, sedges *Cyperus rotundus* L., *Cyperus iria* L., *Fimbristylis miliacea* (L.) Rahl., and broadleaved weeds *Ageratum conyzoides* L., *Ludwigia parviflora* Roxb. and *Spilanthes paniculata* L. compete strongly with jute since its emergence. Multiple nutrient deficiencies owing to coarse textured soil and high invasion of grasses, sedges and broadleaved weeds because of high rainfall during the *pre-kharif* season become the major constraint in jute cultivation. This led to find out soil applicable herbicides which could be able to control varied weed flora in the jute field. In sandy loam soil pre-emergence herbicides often becomes non-selective or less selective to the crop at their usual recommended doses in these areas. This was mainly because of soil texture and soil moisture as revealed by Saraswat and Sharma (1983). Limited availability of soil applied herbicides both in term of recommended herbicides in jute and their market availability, there was a need to make use of some non-traditional herbicides those are widely used in other crops and are easily available in the market. Keeping this view in mind, an attempt has been made to find out some non-tradition herbicides to be used in jute and to determine selectivity index (SI) value and doses for controlling mixed weed flora through bioassay technique. Bioassay is a useful technique for rapidly screening of herbicides for phytotoxicity and dose determination (Sandral *et al.,* 1997). Bioassay is being used widely as a useful tool to regulate herbicide doses in a particular crop. This technique also leads to identify the herbicide that is safe for a crop in terms of phytotoxicity and growth reduction by relating the different herbicidal doses with per cent reduction in fresh weight/dry weight of individual plants (Tag *et al.,* 1981). It involves the biological response of plant species in terms of per cent reduction in dry weight (g plant^{-1}).

For determining selectivity index (SI) values and doses of herbicides, a field experiment was carried out during the *pre-kharif* season of 2011 in the research farm of Uttar Banga Krishi Viswavidyalaya located at Pundibari, Coochbehar, West Bengal. The cultivated jute variety JRO-524 was used in the experiment. The soil of the experimental site was sandy loam in character (Sand 63%, silt 21% and clay 16%) with pH 5.85, organic carbon 0.58%, available nitrogen 123.5 kg ha^{-1}, available phosphorus 18.3 kg ha^{-1} and available potassium 79.2 kg ha^{-1}. The herbicides with their respective doses were applied in the plot size of 3 × 2m area. The herbicides butachlor 50% EC (Machete), pretilachlor 50% EC (Refit) and pendimethalin 38.7% CS (Stomp extra) were tested in the experiment as pre-plant surface application (PPSA) and pre-emergence (PE) with their respective doses (Table 1). Nine treatments relating to the dose of herbicides (butachlor, pretilacholr and pendimethalin) were tested in Complete Randomized Design with two replications.

Visual observations were made every day to understand the changes in growth behavior of the jute plants and appearance of phytotoxic symptom owing to herbicidal toxicity on jute plant at different doses. Both jute and weed plant samples were taken at 25 days after sowing (DAS) from 0.5 × 0.5 m sample area. Biological response of plants to herbicides was determined by measuring the dry weight of the plants grown in herbicide treated soil with different doses and per cent growth inhibition/reduction of plant was calculated by comparing the dry weight of herbicide treated plant with healthy plant from untreated control plot. In control plot 0.5 m × 0.5 m sample area was kept free from weed since emergence of jute plant. The percent growth inhibition values obtained at different herbicidal doses both in case of jute and weed were transformed to probit values and regressed against log values of doses. The linear regression equation was computed by using Excel programme Y=bx+a, where Y indicates probit value of % dry weight reduction, b is regression coefficient, x is log dose of herbicide and a is intercept of Y. Selectivity

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index (SI) value was calculated by using the following formula:

$$\text{Selectivity Index (SI)} = \frac{\text{Maximum dose tolerated by crop (jute)}}{\text{Minimum dose required to control the weeds}}$$

Maximum dose of herbicide tolerated by jute was equal to the dose that caused 20% growth reduction of jute (GR_{20}) at initial stages and minimum dose required to control the weeds was equal to the dose that resulted in 80% growth reduction of weeds (GR_{80}) or 80% weed control efficiency of herbicide. Selectivity index value greater than 1 is always desirable to get selective control over weeds without any lethal effect on crop plant. The proportional increase of plant response in terms of growth reduction to herbicidal doses led to identify the level at which the plant produced 50% response which is known as GR_{50} (dose of herbicide that led to 50% growth reduction). GR_{50} values show relative sensitivity of crops to herbicides (Nel *et al.,* 1995).

Table 1: Dose (kg ha^{-1}) of different herbicides tested in the experiment

Treatments	Pretilachlor 50 % EC (kg ha^{-1})		Butachlor 50% EC (kg ha^{-1})		Pendimethalin 38.7% CS (kg ha^{-1})	
	Pre-plant	PE	Pre-plant	PE	Pre-plant	PE
1	0.00	0.00	0.00	0.00	0.00	0.00
2	0.10	0.10	0.30	0.30	0.20	0.20
3	0.20	0.20	0.50	0.50	0.30	0.30
4	0.30	0.30	0.70	0.70	0.40	0.40
5	0.40	0.40	0.90	0.90	0.50	0.50
6	0.50	0.50	1.10	1.10	0.60	0.60
7	0.60	0.60	1.30	1.30	0.70	0.70
8	0.70	0.70	1.50	1.50	0.80	0.80
9	0.80	0.80	1.70	1.70	0.90	0.90

Table 2: GR_{20} value, GR_{50} value of jute, GR_{80} value of weed and SI value of the herbicides

Herbicides	GR_{20} (kg ha^{-1})	GR_{80} (kg ha^{-1})	Selectivity index	GR_{50} (kg ha^{-1})	Linear regression equation	R^2 value
Pretilachlor PPSA	0.49	0.37	1.32	1.18	Y=2.190 x + 4.837	0.943
Pretilachlor PE	0.55	0.53	1.04	0.86	Y=4.277 x + 5.272	0.813
Butachlor PPSA	1.0	0.86	1.16	1.94	Y=2.905x + 5.161	0.936
Butachlor PE	1.03	0.88	1.17	1.95	Y =3.050x + 4.114	0.851
Pendimethalin PPSA	0.47	0.63	0.76	0.79	Y =3.723x + 5.367	0.984
Pendimethalin PE	0.44	0.57	0.77	0.70	Y=4.152x + 5.635	0.992

Note: PPSA-Pre-plant surface application, PE-Pre-emergence

Weed flora recorded in the experiment

Grasses *Cynodon dactylon* (L.) Pers., *Digitaria ciliaris* (Retz.) Koel, sedges *Cyperus rotundus* L., *Cyperus iria* L., *Fimbristylis miliacea* (L.) Rahl., and broadleaved weeds *Ageratum conyzoides* L., *Ludwigia parviflora* Roxb., *Spilanthes paniculata* L.

Phytotoxicity and selectivity index of herbicides

The phytotoxic effect to jute was manifested with characteristic yellowing and necrotic symptom which appeared within 6-8 days after sowing (DAS) in newly emerged seedling. Appearance of yellowing and necrotic symptom was followed by death of seeding within 10-12 DAS (Rahaman and Mukherjee, 2011). Data in Table 2 reveals that GR_{20} value of jute in case of pretilachlor under pre-plant surface application treatment was 0.49 kg ha^{-1} and GR_{80} value of weed was 0.37 kg ha^{-1} with the SI value of 1.32 whereas in pre-emergence treatment, GR_{20} value of jute and GR_{80} value of weed were 0.55 kg ha^{-1} and 0.53 kg ha^{-1}, respectively, with the SI value of 1.04 (Table 2). Low SI value in pre-emergence treatment made the treatment less selective than that of pre-plant surface application. Therefore, pretilachlor at the dose 0.37 kg ha^{-1} can be applied in jute safely as pre-plant surface application treatment for controlling weeds. Lower GR_{50} value (0.86 kg ha^{-1}) of jute in pre-emergence treatment as compared to pre-plant surface application treatment (1.18 kg ha^{-1}) indicated more phytotoxicity of pretilachlor on jute plant when it was applied as pre-emergence herbicide.

In case of butachlor almost similar values of GR_{20} of jute (1.00 and 1.03 kg ha^{-1}), GR_{50} of jute (1.94 and 1.95 kg ha^{-1}) GR_{80} of weed (0.86 and 0.88

kg ha^{-1}) and SI values (1.16 and 1.17) were obtained in pre-plant surface application and pre-emergence treatments, respectively (Table 2). Therefore, SI value >1 in both the treatments ensured the selectivity of butachlor in pre-emergence as well as pre-plant surface application. Butachlor at the dose of 0.86 to 0.88 kg ha^{-1} can be applied in jute safely as pre-plant surface application and pre-emergence treatment.

SI values <1 in case of pendimethalin (0.79 in and 0.70) at both the treatment indicated non-selective or ineffective nature of herbicide in controlling weeds in jute (Mukherjee *et al.,* 2010). Therefore, it could be concluded for the experiment that the non-traditional herbicides like pretilachlor and butachlor can be used in jute for controlling weeds.

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