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Bioassay Techniques for Dose Determination of Non-Traditional Herbicides in Cowpea (*Vigna unguiculata* (L) Walp.)

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A B S T R A C T

Alachlor is a selective pre-emergence herbicide in legume crops. However, limited availability of these herbicides and widely availability of other (rice) herbicides (Butachlor and pretilachlor) led to need about the use of non-tradition herbicides for controlling weeds. With this view the field experiment was undertaken with the objectives to study bio-efficacy of non-traditional herbicides in cowpea and to work out selectivity index (SI) value and doses for controlling mixed weed flora through bioassay technique. Results generated through the experiment indicated that the pre-emergence application on non-traditional herbicides like butachlor @ 0.77 kg ha^{-1} and pretilachlor @ 0.42 kg ha^{-1} can be applied as pre-emergence treatment in cowpea to achieve control over the weeds. However, among these two herbicides butachlor has higher degree of selectivity than pretilachlor.

Introduction

Cowpea (*Vigna unguiculata* (L) Walp.) is an annual legume that is cultivated mainly for its edible seeds. Among other factors limiting cowpea production, inadequate weed control had been identified as a major contributor factor for yield gap. Uncontrolled weed growth and/or inadequate weed control in the crop have been reported to account for 40-80 % reduction in grain yield (Sunday and Udensi, 2013). Crop losses by weeds could be aggravated by delay in weeding or inability to weed through the entire crop growth period. Cowpea –weed competition starts from germination to harvest, which drastically reduces crop yield (Patel *et al.*, 2003). The weed reduces the vegetative growth, flowering, and seed production of cowpea and it was reported that yield reduction due to weed in cowpea may be upto 82% (Muhammad *et al.*,2003).Hence controlling of weed is important for better yield of crop. The method such as, hand-

hoeing, harrowing and hand-pulling are very costly, in addition to that unavailability of labour during peak period of weed removal increases difficulty to control weed (Khan *et al.*, 2000). Hence, the use of herbicide is a viable option to control weed in cowpea field (Dadari, 2003). The weed specific herbicide are effective in controlling weeds

Then the other traditional ones mentioned above. Presently, existing herbicides for pre-emergence weed control in cowpea are no longer consistent in their spectrum of effective weed control. This may be as a result of some weed becoming resistant to these herbicides (Sunday and Udensi., 2013). 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). In this region the cultivation of vegetable cowpea after winter season vegetables is emerging as a popular cropping system (Chatterjee, 2014). The aggressive growth of weeds comprising 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 cowpea since its emergence. Multiple nutrient deficiencies owing to coarse textured soil and high invasion of grasses, sedges and broadleaved weeds because of high rainfall become the major constraint in crop cultivation. Presently, suitable selective per-emergence herbicides for legume crops like alachlor is not widely available and pendimethalin (Stomp extra) has failed to control the weeds.This led to the need to find out soil applied herbicides which could be able to control mixed weed flora in the cowpea since beginning of crop establishment. In sandy loam soil pre-emergence herbicides at their usual recommended doses often becomes non-selective or less selective to the crop in these areas. This was mainly because of soil texture and soil moisture as revealed by Saraswat and Sharma, 1983; and Mukherjee *et al.*, 2012. Limited availability of soil applied herbicides both in term s of recommended herbicides in cowpea 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 other herbicides to be used in cowpea and to determine selectivity index (SI) value and doses for controlling mixed weed flora through bioassay technique. Bioassay is a method for determination of herbicide dose and phytotoxicity (Sandral *et al.*, 1997).This method also helpful to identify safe herbicide for crop, so that phytotoxicity and growth reduction could not occur (Tag *et al.*,1981).

Materials and Methods

To study the dose determination of non-traditional herbicides in cowpea (*Vigna unguiculata* (L) Walp.) a field experiment was conducted at Uttar Banga Krishi Viswavidyalaya, research farm located at Pundibari, CoochBehar, West Bengal carried out during the pre-Kharif season of 2014 for determining selectivity index (SI) values and doses of herbicides. The experiment was conducted in sandy loam soil. The Lafa variety cowpea seeds were sown by dibble method manually with spacing of 50 x 25 cm. The experimental plot size was 3 x 2m area. The pre-emergence herbicides butachlor 50% EC (Machete) and pretilachlor 50% EC (Refit) were applied in the experiment with their respective doses (Table 1). Randomized Block Design was used with eight

treatments of different doses of butachlor and pretilachlor herbicide which was replicated twice. To identify appearance of phototoxic symptom due to herbicide visual observation were observed on daily basis. After 30 DAS samples of cowpea and weeds were taken from 0.5 x 0.5 m area. Dry weight of plants were recorded to determine biological response ,which were grown in herbicide treated soil and per cent growth inhibition/reduction of plant was calculated by comparing the dry weight of herbicide treated and untreated control plot. The probit values were obtained and regressed against log values of doses by transforming the percent growth inhibition values procured at different herbicidal doses both in case of cowpea and weed. 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 index (SI) value was calculated by using the following formula:

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

Maximum dose of herbicide tolerated by cowpea was equal to the dose that caused 20% growth reduction of cowpea (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 GR50 (dose of herbicide that led to 50% growth reduction). GR50 values show relative sensitivity of crops to herbicides (Nel *et al*., *1995*). Weed flora recorded in the experiment The weed flora recorded in the experimental plot was comprised by broadleaved weeds *Polgyonum spp*., *Physalis minima* L., *Oxalis corniculata* L., sedges *Cyperus rotundus* L., *Cyperus iria* L. , and grasses *Cynodon dactylon* (L.) Pers., *Digitaria ciliaris* (Retz.) Weeds like *Ageratum conyzoides* L., appeared at later part of crop phenophases.

Results and Discussion

Data in Table 2 reveal that the GR 20 value of cowpea in case of butachlor was 1.07 kg ha-1and GR80 value of weed was 0.77 kg ha^{-1} with the SI value of 1.19. S.I value of 1.19 (Table 2) which is greater than 1,shows the selectivity and effective nature of butachlor herbicide in cowpea plant as pre - emergence herbicide and it increase weed control efficiency. Therefore, higher SI value registered by butachlor confirmed that application of butachlor @ 0.77 kg ha^{-1}as pre-emergence treatment will be safe in controlling weeds in cowpea. Incase of pretilachlor the GR 20 value of cowpea and GR 80 value of weed were 0.42 kg ha^{-1} and 0.42 kg ha^{-1}, respectively, with the SI value of 1 (Table 2). SI value equal to 1 indicated marginal selectivity of pretilachlor in cowpea for controlling weeds. From the experimental results it can be concluded that application of non-traditional herbicide butachlor as pre-emergence treatment with the dose of 0.77 kg ha^{-1} could be effective in terms of selectivity compared to pretilachlor.

Table.1 Dose (Kg Ha-1) of Different Herbicides Tested as Pre-Emergence Treatment in the Experiment

Treatments	Butachlor	Pretilachlor
1	0.00	0.00
2	0.10	0.10
3	0.20	0.20
4	0.30	0.30
5	0.40	0.40
6	0.60	0.50
7	0.80	0.60
8	1.00	0.80

Table.2 GR20 value, GR50 value of Cowpea, GR80 value of Weed and Selective Index (SI) value of the Herbicides

Herbicides	GR_{20} (kg ha^{-1})	GR_{50} (kg ha^{-1})	SI	GR_{80} (kg ha^{-1})	Linear regression equation		R^2 value	
					Crop	Weed	Crop	Weed
Butachlor	1.07	4.48	1.19	0.77	Y=2.042x+3.887	Y=5.848x+7.579	0.842	0.975
Pretilachlor	0.42	1.37	1	0.42	Y=2.741x+4.844	Y=7.424X+9.650	0.875	0.939

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