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Evaluation of pre plant herbicides on weed management in transplanted rice at before puddling

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Abstract

Rice is an important food crop extensively grown in India. Several factors are responsible for reducing the rice productivity in worldwide. However, weed infestation is the major biotic threat to productivity of transplanted rice. Weeds are competed with rice by their high adaptability and faster growth, dominate the crop habitat and reduce the yield potential of rice. Weed management is an important agro-technique for successful transplanted rice cultivation. It can be achieved, either manual or mechanical or chemical weed control methods. Even though, hand weeding is an effective method of weed management, scarcity of labour and cost of weeding force the farmers to depend on chemical weed management. Herbicides offer the most effective, economical and practical way of weed management. Weed infestation before puddling may cause severe crop weed competition during early growth stage of rice by their re-emergence. Foliage active pre plant herbicides *viz*., glyphosate, glufosinate ammonium and halosulfuron methyl could be used effectively to control weeds before transplanting rice. As these herbicides would not have much soil activity, succeeding transplanted rice will not be affected. Controlling of emerged weeds leads exhaustion of weed seeds in the top soil and also the problematic weed like *Cyperus* would considerably reduce the weed population in the transplanted rice during early stages resulted in less crop weed competition and better growth and yield of rice.

***Keywords*:** glufosinate ammonium, glyphosate, halosulfuron methyl, preplant application, transplanted rice, Weed management.

Introduction

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Rice (*Oryza sativa* L.) is the staple food for more than 60 per cent of the world population and its cultivation secures a livelihood for more than two billion people. In India, rice is grown in an area of 43.79 million hectare with a production of 112.91 million tonnes and an average productivity of 2.5 t ha^{-1}(Anonymous, 2018). Weeds are the major biotic constraint to reduce the rice productivity in worldwide. In transplanted rice, about 60 % of the weeds emerge in the period between one week to one month after transplanting. These emerging weeds are competing with rice during active tillering stage and decline the quantity of panicles leads to reduction in grain yield.

In most of the rice growing areas, where one rice crop is being grown per year and rest of the period, the fields are left as fallow, weeds grown enormously during off season and poses serious threat in reducing the grain yield of rice. Rainfall during nursery period causes more weeds infestation and multiplication. *Cyperus rotundus* is one of the dominant weed in wetland ecosystem, causes difficulty in land preparation for rice cultivation. In addition, regeneration of *Cyperus* rhizomes and weeds infestation occur during early growth stages of rice due to improper land levelling as well as alternate wetting and drying irrigation pattern causes poor growth and yield of rice. Manual weeding of *Cyperus rotundus* islaborious and increases the cost of weeding. Hence, pre plant application of herbicide can be used for controlling the emerged weeds particularly *Cyperus* before transplanting which causes easy land preparation and less weeds in the rice field.Very few studies have been carried out on the pre plant application of herbicides especially glyphosate on weed management in transplanted rice at before puddling. Hence, present experiment has been carried out to evaluate the pre plant application of different foliage active herbicides on weed management in transplanted rice at before puddling.

Weed flora

Common weed species observed in the field during the course of investigation were *Echinochloa colona* (L.), *Cynodon dactylon* (L.) in grasses, *Cyperus rotundus* (L.) in sedges and *Eclipta alba* (L.), *Euphorbia prostrata* (L.), *Lippia nodiflora* (L.) in broad leaved weeds (BLW). Before spraying of pre plant herbicides, sedges (71%) was found to be the predominant category followed by grasses (18 %) and BLW (11 %)

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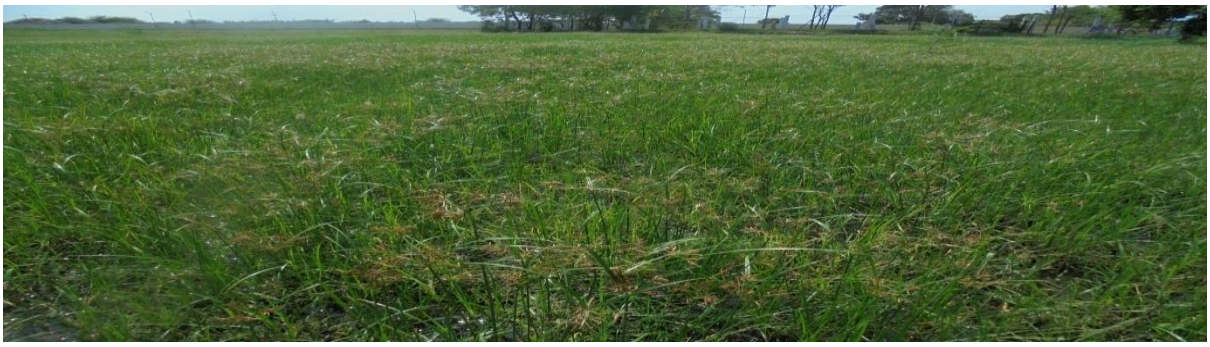

Fig.1. General view of the experimental field at before pre plant application of herbicides

Pre plant application of herbicides

1. Glyphosate (N- (phosphonomethyl) glycine)

Glyphosate is a non-selective, broad spectrum herbicide that is active on many species of green plants through foliar translocation. It is used to control emerged weeds in non-crop situation. It was first introduced in 1974 for post emergence weed control following discovery of its herbicidal properties by John Franz in 1970 (Anonymous, 2005).

Mode of action

Glyphosate inhibits 5-enolpyruvyl shikimate-3-phosphate (EPSP) which led to reducing aromatic amino acids that required for protein synthesis or biosynthetic pathways like tryptophan, tyrosine and phenylalanine resulted in growth failure of plants. It absorbed through foliage and translocated through symplast pathway and accumulates in all the plant parts. Residuality of glyphosate was none (<1month).It is non selective in nature and widely used low cost herbicide (Mueller *et al.*, 2005). It was readily translocated, causing chlorosis, necrosis and finally kill the plant cells (Deeds*et al.*, 2006). Four to seven days after treatment, phytotoxicity occurred in plants (Senseman and scott, 2007).

Effect on weeds

Application of glyphosate 2.5 kg ha^{-1} at 15 days before puddling effectively controlled all the weeds including *Cyperus* within 7 days by inhibiting 5-enolpyruvylshikimate-3-

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phosphate (EPSP) synthase pathway that required for protein synthesis. Further complete drying the field facilitate easy land preparation and required one puddling lesser than control.

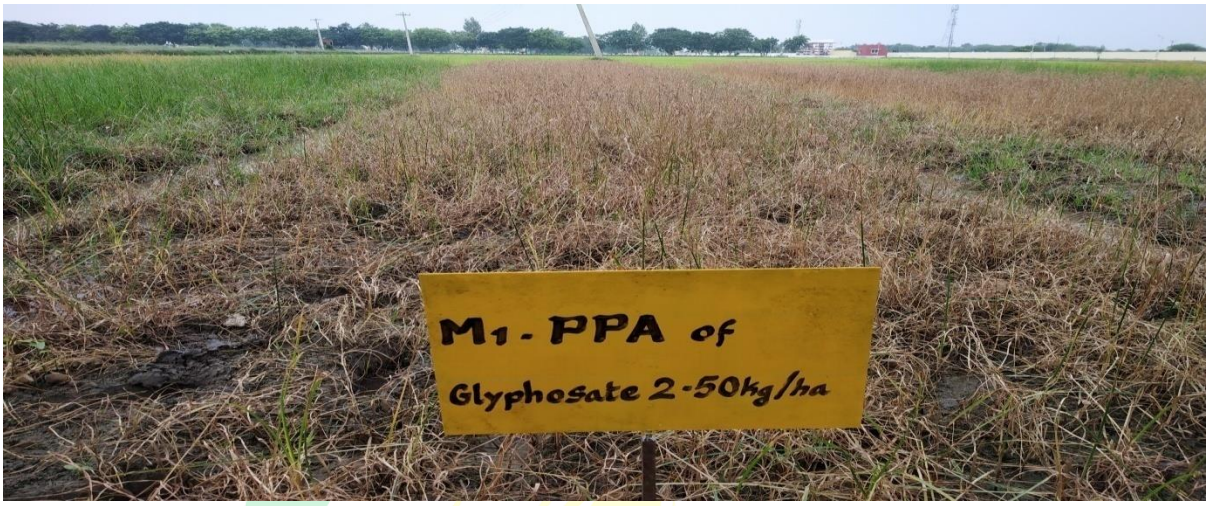

Fig.2. Fifteen days after pre plant application of glyphosate

2. Glufosinate ammonium (2-amino-4-(hydroxymethylphoshinyl) butanoic acid)

Glufosinate ammonium is a contact herbicide, damage is restricted to those parts of the plant that have been in contact with the spray (Pline *et al.*, 1999). It used to control annual and perennial grasses, sedges and BLW in non-cropped situation (Coetzer and Al-Khatib, 2001). According to Everman *et al.* (2009), glufosinate ammonium is readily degraded by microorganisms. It has no residual activity. It has a phosphorus containing amino acid and also known as phosphinothricin is a non-volatile salt, soluble in polar solvents and water and insoluble in non-polar organic solvents. It is a non-selective post emergence contact herbicide (Li *et al.*, 2014). Information on the use of this herbicide as pre plant application in transplanted rice is very limited.

Mode of action

Glufosinate inhibited the activity of glutamine synthase, which is essential for conversion of glutamate plus ammonium to glutamine led to accumulation of ammonia in the plant, resulted in destroying cells directly and inhibits photosystem I and II. Herbicide absorbed mostly through foliage of the plant, small quantity of glufosinate may absorbed

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through roots and limited translocation via xylem and phloem. The chlorosis symptom is visible at 3 to 5 day after transplanting followed by necrosis and death (Senseman and scott, 2007).

Effect on weeds

Pre plant application of glufosinate ammonium 1.0 kg ha^{-1}at 15 days before puddling inhibited the activity of glutamine synthase led to destroy cells directly by inhibited photosystem I and photosystem II reactions caused complete drying of weeds within 5 days including *Cyperus*. Glufosinate ammonium showed complete drying of the weeds (5 days) much faster than glyphosate (7 days). Further complete drying the field facilitate easy land preparation and required one puddling lesser than control.

Fig.3. Fifteen days after pre plant application of glufosinate ammonium

3. Halosulfuron methyl (Methyl 5 - [((4, 6-dimethoxy - 2 pyrimidinyl) amino) carbonyl aminosulfonyl]-3-chloro-1- methy l-1 H-pyrazole - 4 - carboxylate)

Halosulfuron methyl is a selective post emergence herbicide used to control sedge and other weeds. It is belonging to sulfonyl urea group of herbicides. It completely controls the *Cyperus* and reduces tuber viability. Halosulfuron controlled purple nut sedge and similar weeds that are difficult to manage (Suganthi, 2013).

Mode of action

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Halosulfuron methyl comes under sulfonyl urea group of herbicides, used for control the emerged sedges. It affects acetolactate synthase (ALS) enzyme, caused rapid reduction of cell division and plant growth. Growth and development of treated plant inhibit within few hours and susceptible weeds are no longer competitive with the crop. Inhibition of growth followed by chlorotic and necrotic in meristematic areas with complete control typically occurring within 1-2 weeks. The residuality is intermediate (1-4 months) (Suganthi, 2013).

Effect on weeds

Halosulfuron methyl 67.5 g ha^{-1}at 15 days before puddling not effectively controlled the weeds including *Cyperus*. This is mainly becausein the experimental field at the time of halosulfuron application most of the *Cyperus* plants found flowering to maturity stage. Halosulfuron methyl effectively control the *Cyperus* at 3-4 leaf stage only. Hence, it could be find out that halosulfuron methyl does not control the matured *Cyperus rotundus*.

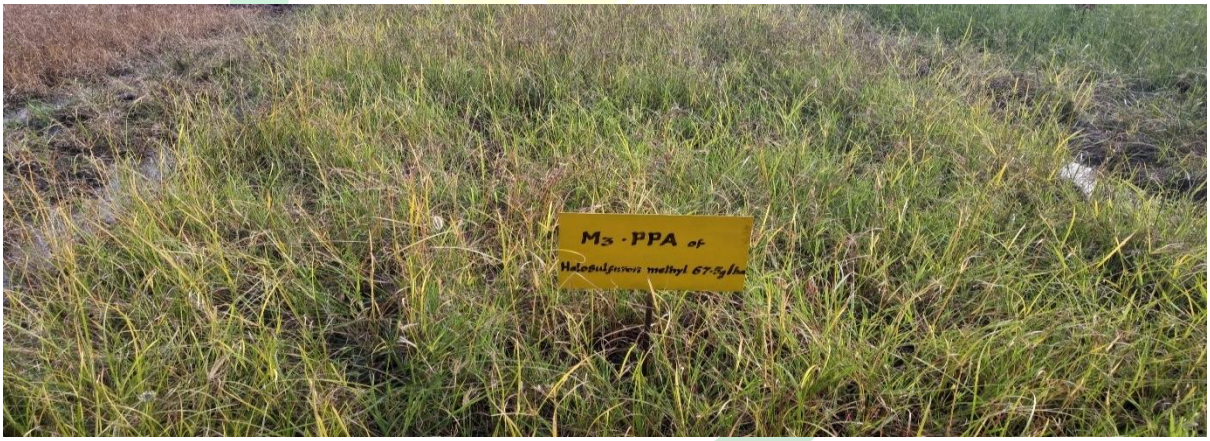

Fig.4. Fifteen days after pre plant application of halosulfuron methyl

Glyphosate controversy

The European parliament representing 28 countries banned glyphosate and its use in households. World Health Organizations finding that the active ingredient in round up is probable human carcinogen and cause blood cancer (Hedlund and Baum, 2019). Widespread use of glyphosate may lead to glyphosate resistant weeds covering 120 million hectares globally in 2010. Glyphosate tolerant crops and other subsequent crops affected by metal chelation. Chelation and immobilization of metal micronutrients such as manganese damages

physiological processes in the plant including disease resistance and photosynthesis. Numerous diseases including gross wilt, fusarium wilt and 40 diseases have been linked to glyphosate use in US reported by Sirinath singh ji and Eva (2018). Recently, glyphosate has been banned in many states in India includes Kerala, Punjab, Maharashtra and Andhra Pradesh. Due to the controversy of glyphosate usage, it is right time to find alternative post emergence herbicide for effective control of weeds.

Conclusion

From the above it could be concluded from the field study, pre plant application of glyphosate or glufosinate ammonium at 15 days before puddling effectively controlled all the weeds including *Cyperus rotundus* within 7 days. However, recent reports on glyphosate toxicity on human beings and banning of glyphosate by some states like Kerala, Punjab, Maharashtra and Andhra Pradesh forced the scientist to find out an alternative herbicide for this. In this field experiment, glufosinate ammonium seems to be effective in controlling weeds.Hence, glufosinate ammonium could be used as alternative herbicide in future considering the negative issues of glyphosate.

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