Short communication

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Enhancing glyphosate translocation by 2,4-D to control purple nutsedge

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Lack of glyphosate translocation to the site of action (growing apex) is the limitation for effective control of purple nutsedge (*Cyperus rotundus* L). Glyphosate is used for weed control in wasteland, zero tillage, directed spray in plantation crops and on quarantine weeds. Senescence of leaf is programmed cell death involving degradation of macromolecules *viz*. proteins, nucleic acids and lipids and during later stage of this process, essential nutrients are remobilizes to the growing apex. Pre-treatment with ethephon (5000 ppm) induced the leaf senescence and reduced callose accumulation in phloem which enhanced 2,4-D and glyphosate translocation and thus their efficacies (Devendra *et al.* 1996). Senescence period of 48 h, induced by glyphosate (1.3 kg/ha) enhanced the efficacy more than 24 or 72 h senescence period (Dhanraj *et al*. 2012). Senescence was found to increase the activity of low affinity (Pht 2,1) phosphate transporter (Daram *et al.* 1999) and high affinity (PhPT1) phosphate transporter (Chapin and Jones 2009). Glyphosate being phosphate having molecule, compete with phosphate with transporter which led to enhanced phloem mobility.

2,4-D, apart from stimulating the enzyme 1-amino-cyclopropane-1-carboxylic acid synthase (ACC-synthase), key enzyme in ethylene production, led to uncontrolled apex groth by increased unwanted DNA, RNA and protein synthesis (Chinalia *et al.* 2007). With this background, attempt was made to assess the pre-treatment of 2,4-D sodium salt for 48 h on glyphosate efficacy in control of perennial *C. rotundus*.

Single *C. rotundus* tuber having same size was planted in a pots of size 30x10x10 cm^3 filled with Kandic Paleustalf–sandy loam soil. Pots were irrigated daily. Twenty-five days after establishment, different treatments, *viz*. 2,4-D sodium salt (2 kg/ha), glyphosate (1.3 kg/ha), 2,4-D sodium salt (1.0 kg/ha) pretreatment 48 h followed by (*fb*) 2,4-D sodium salt (1.0 kg/ha)- (2,4-D *fb* 2,4-D) glyphosate *fb* glyphosate (0.65 *fb* 0.65 kg/ha); 2,4-D *fb* glyphosate in various proportions, *viz.* 1:3, 1:1 and 3:1 were imposed and compared with unsprayed control. There were eight treatments (Table 1) and each treatment had three replications, thus totally 24 plots were used for this study. Pot culture experiment showed that 1:3 proportion of 2,4-D: glyphosate had lowest biomass, hence glyphosate proportions were increased compared to 2,4-D (1:3, 1:4 and 1:5) and treatments were tried under field condition.

Already infested purple nutsedge field was divided into micro plots of size of 2 x 2 m^2 each. Eleven treatments with modified 2,4-D *fb* glyphosate in various proportions *viz.* 1:3, 1:4 and 1:5 were tried. Further, these proportions of 2,4-D and glyphosate used in treatment 6, 7 and 8 were tank mixed and sprayed (Table 2). Each treatment had three replications. Thus, there were 33 plots under micro-plot conditions. Total biomass was recorded 45 days after last spray in both experiments and data was analyzed statistically the Decan's range test was used to assess the significance difference between herbicides and their combination using MSTATC software.

Entry and translocation is the limitation to reduce the dosage of herbicides without affecting their efficacy. In this investigation, attempts were made to reduce the dosage of both herbicide based on their mode of actions. Total biomass of *C. rotundus* data showed that all the herbicide treatments had significantly low biomass compared to unsprayed control both under pot culture and field conditions (Table 1 and Table 2). Under pot culture, lowest biomass was recorded by 1:3 proportion of 2,4-D *fb* glyphosate compared to other treatments it was efficient than 2,4-D alone or 2,4-D *fb* 2,4-D treatments. Rest of the treatments had same effect on reducing the biomass of the weed plant. Though glyphosate (1.3 kg/ha) alone had similar effect of 1:3 proportion of 2,4-D *fb* glyphosate, 2,4-D *fb* glyphosate had relatively more effective in recording lowest biomass and allows reduction in dosage of both herbicides. In 1:3 proportion, 2,4-D concentration was low compared to other proportions. Chinalia *et al.* (2007) suggested that lower the dose of 2,4-D led to

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Table 1. Effect of herbicides and their combinations on total biomass of *Cyperus rotundus* in pot culture

Treatment	kg/ha	Total biomass (g/pot)
Unsprayed control	-	81.0
2,4-D Na salt	2.00	8.1
Glyphosate	1.30	3.4
25% of 2,4-D *fb*75% of glyphosate (1:3)	0.50 *fb* 0.97	2.5
50% of 2,4-D *fb* 50% of glyphosate (1:1)	1.00 *fb* 0.65	5.8
75% of 2,4-D *fb* 25% of glyphosate (3:1)	1.50 *fb* 0.32	7.0
Glyphosate *fb* glyphosate	0.65 *fb* 0.65	5.7
2,4-D *fb* 2,4D	1.0 *fb* 1.0	24.4
LSD (P=0.05)		15.63

fb = Followed by (48 h pre-treatment with 2,4-D or glyphosate)

Table 2. Effect of herbicides and their combinations on total biomass of *Cyperus rotundus* in field (micro-plot of size 2 x 2 m^2)

Treatment	kg / ha	Total biomass (g / m^2)
Unsprayed control	-	655.2
2,4-D Na salt	2.00	324.8
Glyphosate	0.75	391.2
Glyphosate	1.5	148.0
Glyphosate *fb* glyphosate	0.75 *fb* 0.75	281.2
25% of 2,4-D *fb* 75% of glyphosate (1:3)	0.5 *fb* 1.1	118.8
20% of 2,4-D *fb* 80% of glyphosate (1:4)	0.3 *fb* 1.26	300.0
16% of 2,4-D *fb* 84% of glyphosate (1:5)	0.25 *fb* 1.35	348.0
25% of 2,4-D + 75% of glyphosate (1:3)	0.5 + 1.1	375.2
20% of 2,4-D + 80% of glyphosate (1:4)	0.3 + 1.26	440.8
16% of 2,4-D + 84% of glyphosate (1:5)	0.25 + 1.35	506.8
LSD (P=0.05)		283.2

lowering of the reactive oxygen species (ROS) production, which is one of the mode of action of 2,4-D, thus facilitated membrane intactness and more phosphate transporter action thus increased phloem loading and mobility of glyphosate. Thus in pot culture, percent reduction in nut sedge biomass over unsprayed control in 2,4-D *fb* 2,4-D was 70.4% whereas in 2.4-D alone it was 90%. In glyphosate *fb* glyphosate and glyphosate alone, the percent reduction in weed biomass were 93 and 95% respectively. Whereas in 2,4-D *fb* glyphosate the percent reduction was 97% which was highest amongst all treatments.

Under field condition, an attempt was made to increase the glyphosate concentration than 2,4-D in other proportions, *viz*. 1:3, 1:4 or 1:5. 2,4-D *fb* glyphosate, especially at 1:3 proportion, had lowest biomass compared to other proportions or tank mixed application of these two herbicides. 2,4-D *fb* glyphosate (1:3) had 82% reduced biomass over unsprayed control compared to 77 and 57% reduction over control in glyphosate (1.5 kg/ha) and glyphosate *fb* glyphosate (0.75 *fb* 0.75 kg/ha) (Table 2). Tank mixing of varies proportion of 2,4-D and glyphosate did not showed significant reduction in weed biomass compared to 2,4-D *fb* glyphosate application. Thus, dosage of both herbicides can be reduced from recommended dose in 2,4-D *fb* glyphosate treatment to get maximum suppression of the weed. Application of double the dose of these herbicides in 1:3 proportion might lead to 90% purple nutsedge control under filed condition.

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