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Short communication

Sequential application of pre-and post-emergence herbicides to control mixed weed flora in maize

Shaik Nazreen and D. Subramanyam*
Department of Agronomy, S.V. Agricultural College, Acharya NG Ranga Agricultural University, Tirupati, Andhra Pradesh 517 502

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Maize (*Zea mays* L.) is the most versatile food crop of global importance. In India, maize is cultivated in an area of 9.18 million hectares with a production of 24.17 million tonnes and average productivity of 2.63 t/ha. The low yield of maize under Indian conditions is attributed due to a number of factors, among which weeds rank as prime one. Weed infestation in maize was reported to reduce the yield to the extent of 70.27 per cent (Malaviya and Singh 2007). Among the weeds associated with maize, *Cyperus rotundus* is the dominant weed in Southern Agro-climatic Zone of Andhra Pradesh, India. The recommended pre-emergence herbicides *i.e.* atrazine is less effective against certain weeds associated with maize especially, *Cyperus rotundus*. Hence, the present investigation was undertaken to determine the bioefficacy of sequential application of herbicides either alone or in combination to suppress the weed growth in rainy season maize.

A field experiment was conducted during rainy season, 2016 at S.V. Agricultural College Farm Tirupati, Andhra Pradesh, India. The soil of the experimental field was sandy loam in texture and neutral in reaction. The experiment was laid out in a randomized block design with ten treatments and replicated thrice (**Table 1**). Maize *'DHM-117'* was sown with a spacing of 60 x 20 cm. Recommended dose of fertilizer 200 kg N, 60 kg P_2O_5 and 50 kg K_2O/ ha was applied. Entire dose of phosphorous and potassium and 1/4th dose of nitrogen were applied as basal. Remaining nitrogen was applied at knee height, tasselling and silking stages. Category wise weed density and dry weight was recorded at 60 DAS by adopting standard procedures. The weed data was subjected to square root transformation ($\sqrt{X+0.5}$) before statistical analysis. The number of seeds/cob, test weight and seed yield of maize were recorded at harvest.

***Corresponding author:** subbuagro37@gmail.com

Weed flora, density and biomass

The predominant weeds associated with crop were *Cyperus rotundus* (55%), *Digitaria sanguinalis* (12%), *Boerhavia erecta* (8%), *Borreria hispida* (6%), *Trichodesma indicum* (5%), *Phyllanthus niruri* (4%) and *Digera arvensis* (3%).

The lowest density and biomass of grasses and broad-leaved weeds were registered with PE application of alachlor 1000 g/ha *fb* PoE application of halosulfuron-methyl 67.5 g/ha + tembotrione 100 g/ha, which is the next best to hand weeding twice. Among the sequential application of herbicides, PE application of alachlor 1000 g/ha *fb* tembotrione 100 g/ha was found effective in suppressing the density and biomass of grasses and broad-leaved weeds most effectively than alachlor 1000 g/ha *fb* halosulfuron-methyl 67.5 g/ha. Tembotrione inhibits 4-hydroxyphenyl pyruvate dioxygenase, a key enzyme responsible for the biosynthesis of plastoquinone leads to bleaching of foliage (Pallet *et al.*1997). Among the herbicidal treatments, the lowest density and biomass of sedges was associated with PE application of alachlor 1000 g/ha *fb* PoE application of halosulfuron-methyl 67.5 g/ha. Pre-emergence application of alachlor 1000 g/ha might have suppressed the sprouting of *Cyperus rotundus* at early stage of the crop growth and post-emergence application of halosulfuron-methyl 67.5 g/ha significantly reduced density and biomass of sedges more effectively compared to rest of the PoE herbicides tested. Halosulfuron-methyl 67.5 g/ha is very effective in suppressing the growth and development treatments of *Cyperus rotundus* (Chand *et al.* 2014). The lowest density and dry weight of all the categories of weeds were recorded with PE application of alachlor 1000 g/ha *fb* PoE application of halosulfuron-methyl 67.5 g/ha + tembotrione 100 g/ha as tank mix application. Among the herbicides

Table 1. Effect of sequential application of pre-and post-emergence herbicides on weed density, biomass and yield of maize

Treatment	Weed density (no/m^2)				Weed biomass (g/m^2)				No. of seeds/ cob	Test weight (g)	Seed yield (t/ha)
	Grasses	Sedges	BLW's	Total	Grasses	Sedges	BLWs	Total			
Alachlor (1000 g/ha) 1 DAS	5.08 (25.33)	6.77 (45.33)	6.60 (43.00)	10.68 (113.66)	5.14 (25.87)	8.43 (70.52)	4.52 (19.94)	10.81 (116.33)	301.7	25.24	3.49
Halosulfuron-methyl (67.5 g/ha) 20 DAS	34.33 (5.90)	27.33 (5.28)	46.66 (6.87)	108.32 (10.43)	65.65 (8.13)	10.94 (3.38)	27.60 (5.30)	10.23 (104.19)	241.8	24.01	2.95
Tembotrione (100 g/ha) 20 DAS	5.24 (27.00)	7.60 (57.33)	5.46 (29.33)	10.68 (113.66)	7.45 (55.00)	8.11 (65.28)	3.56 (12.16)	11.53 (132.44)	248.2	24.78	3.33
Halosulfuron-methyl *fb* tembotrione (67.5 + 100 g/ha) 20 DAS	4.98 (24.33)	4.71 (21.66)	5.02 (24.66)	8.43 (70.65)	4.95 (24.01)	2.15 (4.12)	3.39 (11.02)	6.30 (39.15)	325.5	26.56	3.84
Alachlor *fb* halosulfuron-methyl (1000 + 67.5 g/ha) 1 + 20 DAS	4.26 (17.66)	4.34 (18.33)	4.53 (20.00)	7.52 (55.99)	4.02 (15.64)	2.21 (4.39)	3.28 (10.26)	5.55 (30.29)	364.4	27.33	4.19
Alachlor *fb* tembotrione (1000 + 100 g/ha)1 + 20 DAS	3.39 (11.00)	5.76 (32.66)	3.49 (11.66)	7.47 (55.32)	3.42 (11.17)	7.48 (55.45)	2.34 (4.98)	8.49 (71.60)	390.0	28.35	4.31
Alachlor *fb* halosulfuron-methyl+ tembotrione (tank mix) (1000 + 67.5 + 100 g/ha) 1 + 20 DAS	2.35 (5.00)	4.18 (17.00)	2.35 (5.00)	5.24 (27.00)	3.33 (10.62)	1.68 (2.32)	2.27 (4.65)	4.25 (17.59)	447.8	29.04	4.86
Atrazine *fb* 2,4-D sodium salt (1000 + 800 g/ha) 1 + 20 DAS	4.45 (19.33)	5.58 (30.66)	4.14 (16.66)	8.19 (66.65)	4.39 (18.80)	4.63 (20.91)	2.34 (4.97)	6.72 (44.68)	340.5	26.67	4.05
Two hand weedings (g/ha)20 and 40 DAS	1.78 (2.66)	5.08 (25.33)	1.68 (2.33)	5.55 (30.32)	1.40 (1.46)	2.72 (6.89)	1.58 (2.00)	3.29 (10.35)	443.3	28.33	4.55
Unweeded check	6.62 (43.33)	10.09 (101.33)	8.18 (66.33)	14.54 (210.99)	9.75 (94.57)	8.88 (78.42)	7.49 (55.62)	15.14 (228.61)	206.4	23.58	2.25
LSD (p=0.05)	0.18	0.15	0.22	0.24	0.22	0.26	0.16	0.32	14.37	0.33	0.21

Original values are given in parentheses, which were transformed to $\sqrt{x+0.5}$

alone, PoE application of tembotrione 100 g/ha was very effective in suppressing grasses and broad-leaved weeds, where as halosulfuron-methyl 67.5 g/ ha was very effective in controlling sedges.

Significantly higher number of seeds/cob and test weight was recorded with sequential application of alachlor 1000 g/ha as PE *fb* PoE application of halosulfuron-methyl 67.5 g/ha + tembotrione 1000 g/ ha and it was statistically comparable with two hand weedings at 20 and 40 DAS. Kumar *et al.* (2013) also reported that post-emergence application of atrazine 1000 g/ha + halosulfuron-methyl 90 g/ha recorded significantly higher stature or growth and yield components. The increase in number of seeds/cob in the former weed management practice was 53% compared to unweeded check. Pre-emergence application of alachlor 1000 g/ha *fb* PoE application of halosulfuron-methyl 67.5 g/ha + tembotrione 100 g/ha recorded significantly higher grain yield due to maintenance of weed free environment during critical period of crop weed competition as a result of effective control of all the categories of weeds. Hand weeding twice at 20 and 40 DAS was the next best weed management practice in recording higher number of seeds/cob and grain yield of maize. Among the PoE application of herbicides, tank mix application of halosulfuron-methyl 67.5 g/ha+ tembotrione 100 g/ha recorded significantly higher grain yield followed by tembotrione 100 g/ha and halosulfuron-methyl 67.5 g/ha alone.

SUMMARY

A field experiment was laid out in randomized block design with ten weed management practices to determine the bioefficacy of PoE herbicides, halosulfuron-methyl 67.5 g/ha and tembotrione 100 g/ha alone or tank mix and sequential application after PE application of alachlor 1000 g/ha, besides two hand weedings and unweeded control. The broad-spectrum weed control and the highest grain yield of rainy season maize was obtained with sequntial application of alachlor 1000 g/ha as PE *fb* PoE application of halosulfuron-methyl 67.5 g/ha + tembotrione 100 g/ha (tank mix). Post-emergence application of halosulfuron-methyl 67.5 g/ha effectively controlled purple nutsedge.

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