Indian Journal of Weed Science **49**(4): 403–404, 2017
DOI: 10.5958/0974-8164.2017.00103.4

Short communication

Pre- and post-emergence herbicides for weed control in maize

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Received: 17 July 2017; Revised: 4 November 2017

Key words: Maize, Pre- and post-emergence herbicides, Weed control efficiency, Weed density

Maize (*Zea mays* L.) is one of the most versatile cereal crops having wider adaptability under diverse soil and climatic conditions. There are various causes of low productivity of maize and severe weed infestation is one of the major ones. Initial slow growth and wider row spacing of crop provide enough opportunity for the weeds to emerge and offer severe competition. Weeds, if left uncontrolled mitigates the benefits obtainable from different agricultural inputs. Hence, management of weeds is considered to be an important factor for achieving higher productivity. Even though herbicides are effective in controlling weeds, application of single pre-emergence (PE) or post-emergence (PoE) herbicide does not provide satisfactory weed control for desired period (Malviya and Singh 2007). Keeping this in view, an experiment was carried out to study the efficacy of sequential application of pre- and post-emergence herbicides in controlling weeds in maize.

A field experiment was conducted at Agricultural College Farm, Bapatla during *Kharif* 2015. The soil of experimental site was clay loam in texture, slightly alkaline in reaction, low in organic carbon and nitrogen, medium in available phosphorous and high in available potassium. The experiment was laid out in a randomized block design with three replications involving eight treatments. Treatments comprised of atrazine (1.0 kg/ha), halosulfuron-methyl (90 g/ha) and pendimethalin (1.0 kg/ha), and their combinations, hand weeding twice at 20 and 40 DAS, weed free and weedy check (**Table 1**). The maize hybrid '*30-V-92*' was dibbled manually at spacing of 60 × 20 cm using 25 kg seed/ha during last week of August, 2015. Thinning and gap filling was done at 10 days after seeding (DAS) by keeping one seedling/hill. Atrazine and pendimethalin were applied as PE and halosulfuron-methyl was applied as PoE application. Recommended dose of 120:60:60 kg/ha nitrogen, phosphorus and potassium were applied in the form of urea, single super phosphate (SSP) and muriate of potash (MOP).

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Weed density

Among the herbicides tested, pre-emergence application of atrazine 1.0 kg/ha *fb* halosulfuron-methyl 90 g/ha as post-emergence recorded the lowest weed density of 4.6 and 5.7/m^2 at 30 and 60 DAS, respectively, which was found statistically at par with pendimethalin 1.5 kg/ha PE followed by (*fb*) halosulfuron-methyl 90 g/ha as POE and was significantly superior to PE application of atrazine 1.0 kg/ha, PE application of pendimethalin 1.5 kg/ha PE *fb* halosulfuron-methyl 90 g/ha PoE (**Table 1**). The weedy check recorded the highest weed density of 12.3 and 14.2/m^2 at 30 and 60 DAS, respectively over the rest of the treatments. Persistence of atrazine for longer period might have resulted in less weed population in weedy check treatment. Similar trend was observed at harvest stage also as that of the 30 and 60 DAS. These results were in agreement with the findings of verna *et al.* (2009) and Kumar *et al.* (2013).

Weed biomass

Weed free recorded the lowest weed biomass (0.7, 0.7 and 0.7 g/m^2 at 30, 60 DAS and at harvest, respectively) and was significantly lower compared to all the other treatments. With regard to herbicide treatments, the lowest weed biomass (4.6 and 6.3 g/m^2 at 30 and 60 DAS, respectively) was recorded with atrazine 1.0 kg/ha PE *fb* halosulfuron-methyl 90 g/ha PoE, which was at par with pendimethalin 1.5 kg/ha PE *fb* halosulfuron-methyl 90 g/ha PoE. Atrazine 1.0 kg/ha PE, pendimethalin 1.5 kg/ha PE *fb* halosulfuron-methyl 90 g/ha PoE were significantly inferior to weedy check (**Table 1**). These results were in agreement Srividya e*t al.* (2011).

Weed control efficiency

The highest weed control efficiency (90.0, 90.0 and 90.0% at 30, 60 DAS and at harvest, respectively) was recorded with weed free treatment. Among various herbicides tested, atrazine 1.0 kg/ha PE *fb* halosulfuron-methyl 90 g/ha PoE recorded the highest weed control efficiency (69.4 and 68.1% at

Table 1. Weed density and weed biomass as influenced by different weed management treatments in maize

Treatment	Weed density (no./m^2)*			Weed biomass (g/m^2)*		
	30 DAS	60 DAS	At Harvest	30 DAS	60 DAS	At Harvest
Atrazine 1.0 kg/ha (PE 2 DAS)	5.8(33)	8.0(64)	7.2(52)	6.6(44)	9.2(85)	8.9(79)
Halosulfuron-methyl 90 g/ha (PoE 20 DAS)	6.8(46)	9.3(85)	8.8(77)	9.1(81)	10.6(111)	9.4(87)
Pendimethalin 1.5 kg/ha (PE 2 DAS)	6.1(37)	8.3(69)	7.7(59)	6.9(47)	9.6(98)	9.2(84)
Atrazine 1.0 kg/ha (PE) *fb* halosulfuron-methyl 90 g/ha (PoE)	4.6(21)	5.7(32)	5.2(27)	4.6(20)	6.3(39)	7.0(49)
Pendimethalin 1.5 kg/ha (PE) *fb* halosulfuron-methyl 90 g/ha (PoE)	4.7(23)	6.0(32)	5.4(28)	4.8(22)	6.6(44)	7.3(54)
Hand weeding at 20 and 40 DAS	3.6(13)	4.8(23)	4.6(21)	3.6(13)	5.2(27)	6.5(43)
Weedy check	*12.3(152)	14.2(2023)	10.9(120)	*13.0(168)	16.7(279)	13.1(173)
Weed free	0.7(0)	0.7(0)	0.7(0)	0.7(0)	0.7(0)	0.7(0)
LSD (p=0.05)	1.0	1.0	1.0	1.1	1.4	1.6

*The data are $\sqrt{X+0.5}$ transformed. The figures in parentheses are the original values; DAS = Days after seeding; *fb* = Followed by

Table 2. Weed control efficiency as influenced by different weed management treatments in maize

Treatment	Weed control efficiency (%)			
	30 DAS	60 DAS	At harvest	Yield (t/ha) kernel yield
Atrazine 1.0 kg/ha (PE 2 DAS)	59.2(73.2)	56.4(69.2)	47.6(54.5)	5.14
Halosulfuron-methyl 90 g/ha (PoE 20 DAS)	45.7(51.2)	50.6(59.6)	44.2(48.6)	4.78
Pendimethalin 1.5 kg/ha (PE 2 DAS)	57.8(71.6)	53.6(64.7)	45.2(50.4)	4.99
Atrazine 1.0 kg/ha (PE) *fb* halosulfuron-methyl 90 g/ha (PoE)	69.4(87.6)	68.1(85.9)	57.4(70.6)	6.49
Pendimethalin 1.5 kg/ha (PE) *fb* halosulfuron-methyl 90 g/ha (PoE)	68.7(86.7)	66.8(84.5)	55.9(68.2)	6.26
Hand weeding at 20 and 40 DAS	74.1(92.3)	72.0(90.3)	60.4(75.3)	6.74
Weedy check	*0.0(0.0)	0.0(0.0)	0.0(0.0)	3.20
Weed free	90.0(100.0)	90.0(100.0)	90.0(100.0)	7.43
LSD (p=0.05)	6.0	5.2	8.9	0.90

*The data are arc sine transformed. The figures in parentheses are the original values; DAS = Days after seeding; *fb* = Followed by

30 and 60 DAS, respectively), which was at par with pendimethalin 1.5 kg/ha PE *fb* halosulfuron-methyl 90 g/ha PoE at 30 and 60 DAS (**Table 2**). These results were in line with the findings of Kumar *et al*. (2013).

Yield

Among the various weed control treatments, the highest grain yield (7.43 t/ha) was recorded with weed free, which was at par with hand weeding at 20 and 40 DAS. With regard to herbicide treatments, pre-emergence application of atrazine 1.0 kg/ha + halosulfuron-methyl 90 g/ha as PoE recorded the highest grain yield (6.49 t/ha) and it was comparable with pendimethalin 1.5 kg/ha PE *fb* + halosulfuron-methyl 90 g/ha PoE and significantly superior to atrazine 1.0 kg/ha (PE) *fb* halosulfuron-methyl 90 g/ ha (PoE), hand weeding at 20 and 40 DAS and pendimethalin 1.5 kg/ha (PE) *fb* halosulfuron-methyl 90 g/ha (PoE) treatments (**Table 2**).

Among the chemical weed control treatments, the lowest weed density, biomass and the highest weed control efficiency were recorded with pre-emergence application of atrazine 1.0 kg/ha + post-emergence application of halosulfuron-methyl 90 g/ ha and PE application of pendimethalin 1.5 kg/ha + PoE application of halosulfuron-methyl 90 g/ha treatments. However, these two treatments were statistically at par with each other.

SUMMARY

Experiment was carried out during *Kharif*, 2015 at Agricultural College Farm, Bapatla. Among the herbicides tested, pre-emergence application of atrazine 1.0 kg/ha + post-emergence application of halosulfuron-methyl 90 g/ha registered the lowest density (no./m^2) and biomass of weeds (g/ha) and highest weed control efficiency (%) and yield of maize and this was statistically at par with pre-emergence application of pendimethalin 1.5 kg/ha + post-emergence application of halosulfuron-methyl 90 g/ha.

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