Research Article

Effect of New Generation Herbicides on Density and Dry matter of Weeds and Yield of Spring Maize

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Abstract

A field experiment was conducted at Regional Research Station, CCS HAU, Karnal, Haryana during *spring* season 2016, randomly block designed replicated three times, containing spray of different herbicides *viz.* atrazine, alachlor, metribuzin, 2,4-D, tembotrione and manual or mechanical hoeing alone or in combination with each other. All the treatments gave significant results in reduction of all type of weeds at all stages of crop growth and enhanced growth, yield and yield attributes of crop. Application of alachlor 2000 g ha^{-1} as PRE *fb* tembotrione 120 g ha^{-1} + surfactant found to be very effective in controlling all types of weeds at different stages of crop growth and having lower weed density (2.3, 9.7 and 12.3 number m^2) and dry matter of weeds (0.8, 29.9 and 51.0 g m^2) at 40, 60 and 80 DAS, respectively. This treatment was found economical superior to other treatments and having highest return over variable cost (Rs. 68205 ha^{-1}) and B: C ratio (2.41).

Keywords: Spring maize, tembotrione, weed dry matter, weed density, alachlor

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Introduction

Maize is the third most important food cereal crop of the India after Wheat and Rice. Maize is known as the queen of cereals because it has the highest genetic potential amongst the cereals owing to its better dry matter accumulation efficiency in a unit area and time. Today, it has become one of the leading food grain crops in many parts of the world, not only in tropical and subtropical areas but also in temperate and hill ecologies [1]. Initial growth of the maize is slow, having wider spacing and adequate moisture favour the growth of weeds even before crop emergence. Application of single herbicide dose does not help in controlling the weeds for the desired period. Continuous use of single herbicide is known to result in the evolution of herbicide-resistance in weed species and shift in weed flora. First 30-60 days after sowing (DAS) in maize are considered as critical for weed interference [2]. Due to heavy rains, weed infestation becomes unmanageable using the tradition method during entire vegetative and early reproductive stages of maize growth. Reduction in yield to the extent due to weed growth in maize is 32.4 to 42.3% [3]. At present farmers are applying only atrazine as pre-emergance and 2,4-D as post emergence in maize, but these herbicides control only broad leaf weeds. Control of grasses and sedges remain a problem for the farmers, especially when too high or low soil moisture hinders the inter-cultural operation and scarcity of labour during critical stages of weeding. Weed flora changes with change in cultivation practices, type of weed control practices followed and change in cropping system. So it becomes imperative to study the type of weed flora and their chemical control in spring maize particularly post-emergence chemical control. Hence, present study was undertaken to evaluate the efficacy of new herbicides available in the market for complex weed control in spring maize.

Material and Methods

A field experiment was conducted at Regional Research Station of CCS Haryana Agricultural University, Uchani, Karnal, Haryana during S*pring* season 2016. It is situated in semi-arid conditions at an elevation of 245 meters above mean sea level with latitude of 29^0 43' N in the North and longitude of 76^0 58' E in the East in sub-tropical zone. The mean maximum temperature is as high as 45^0C during summer (May-June) and minimum temperature near 0^0C accompanied by frost in peak winter months (December and January) is common feature of the climate of this region. The average annual rainfall of region is 600 mm. The crop was sown on 7th Feb. 2016. The soil of the experimental field was clay loam in texture, medium in organic carbon, medium in available nitrogen and phosphorus but high in available potassium. The experiment consisting of eighteen treatments viz., atrazine 750 g ha^{-1} PRE (T_1), atrazine 750

g ha^{-1} *fb* 2,4 D 500 g ha^{-1}at 30DAS(T_2), atrazine 750 g ha^{-1} *fb* 1 hoeing at 30 DAS (T_3), One hoeing at 20 DAS *fb* atrazine 750 g ha^{-1} at 30 DAS (T_4), alachlor 2.0 kg ha^{-1} PRE (T_5), alachlor 2000 g ha^{-1} *fb* hoeing (T_6), alachlor 1.0 kg ha^{-1} PRE *fb* 2,4-D 500 g ha^{-1} at 30 DAS (T_7), atrazine 375 g ha^{-1} + alachlor 1.0 kg ha^{-1} PRE (T_8), tembotrione 120 g ha^{-1} + surfactant 1000 ml ha^{-1} (T_9), tembotrione 140 g ha^{-1} + surfactant 1000 ml ha^{-1} (T_{10}), alachlor 2000 g ha^{-1} *fb* tembotrione 120 g ha^{-1} + S (T_{11}), metribuzin 400 g ha^{-1} PRE (T_{12}), metribuzin 500g ha^{-1} PRE (T_{13}), atrazine 750 g ha^{-1} *fb* tembotrione 120 g ha^{-1} + S ($_{14}$), manual hoeing (T_{15}), mechanical hoeing at 20 and 40 DAS (T_{16}), weedy check (T_{17}) and weed free (T_{18}) was laid out in Randomized Block Design (RBD) and replicated three times. The recommended dose of fertilizer was 150-60-60 kg of N, P_2O_5 and K_2O/ha. Singe cross quality protein maize hybrid 'HQPM-1' was sown at a depth of 4-5 cm with a spacing of 70 x 20 cm using seed rate of 20 kg/ha. Rests of the inputs were given as per package of practices of the region. Manual hoeing was done with the help of spade in hoeing treatments. All the chemicals were sprayed by using hand operated knapsack spray pump fitted with flat fan nozzle. The weeds were collected as grassy, sedges and broad leaved weeds. Observations on weed density and weed dry matter were recorded by using quadrate of 0.5 x 0.5 m^2. The crop was harvested on 25 may 2016. The economic parameters of different treatments were calculated based on prevailing market price of inputs and outputs.

Table 1 Effect of weed control treatments on total wed density (number^{-2}) and weed dry matter (g m^{-2}) at different stages of crop growth in spring maize

Tr. No.	Treatments	Dose (g ha^{-1})	Time of application	Density of weeds (No. m^{-2})			Dry matter (g m^{-2})		
				40 DAS	60 DAS	80 DAS	40 DAS	60 DAS	80 DAS
T_1	Atrazine	750	PRE	9.6(91.0)	10.2(103.3)	9.2(84.7)	11.7(137.9)	16.6(275.8)	16.5(276.0)
T_2	Atrazine *fb* 2,4-D	750 &500	PRE & 30 DAS	8.7(75.0)	9.1(82.4)	8.4(70.3)	10.8(115.7)	14.6(214.6)	14.8(219.5)
T_3	Atrazine *fb* one hoeing	750	PRE & 30 DAS	7.6(57.7)	8.1(64.7)	7.8(61.3)	8.6(74.0)	11.4(128.5)	12.9(165.7)
T_4	One hoeing *fb* atrazine	500	20 & 30 DAS	7.8(61.3)	8.3(69.0)	8.1(64.7)	9.1(82.4)	11.9(143.2)	13.3(178.4)
T_5	Alachlor	2000	PRE	4.1(16.0)	4.7(21.7)	4.8(23.0)	6.3(38.3)	8.6(73.0)	10.0(99.9)
T_6	Alachlor *fb* hoeing	2000	PRE & 30 DAS	3.5(11.3)	4.4(18.7)	4.5(19.7)	5.5(28.9)	7.8(61.4)	9.2(84.6)
T_7	Alachlor *fb* 2,4-D	1000 & 500	PRE & 30 DAS	4.6(20.3)	4.8(22.7)	5.0(24.0)	6.8(46.2)	8.8(77.1)	10.2(105.0)
T_8	Atrazine + alachlor	375 &1000	PRE	4.6(20.7)	5.0(24.7)	5.0(24.3)	6.2(37.4)	8.5(72.1)	9.6(92.8)
T_9	Tembotrione + surfactant	120 + 1000	25 DAS	3.1(9.0)	4.4(18.7)	4.7(21.0)	4.6(20.5)	7.2(51.5)	8.3(69.2)
T_{10}	Tembotrione + surfactant	140 + 1000	25 DAS	2.8(7.3)	4.1(16.3)	4.5(19.7)	4.2(16.6)	6.6(43.8)	7.9(62.7)
T_{11}	Alachlor *fb* tembotrione + S	2000 & 120	PRE & 25 DAS	1.8(2.3)	3.2(9.7)	3.6(12.3)	1.3(0.8)	5.5(29.9)	7.1(51.0)
T_{12}	Metribuzin	400	PRE	8.4(71.0)	8.9(78.3)	8.3(68.7)	10.6(111.8)	14.3(205.2)	15.0(224.8)
T_{13}	Metribuzin	500	PRE	8.2(67.7)	8.6(74.3)	8.2(66.7)	10.3(105.1)	13.7(189.4)	14.5(209.8)
T_{14}	Atrazine *fb* tembotrione+ S	750 & 120	PRE & 25 DAS	2.5(5.7)	4.2(16.7)	4.5(19.7)	2.6(5.8)	6.5(42.1)	7.8(59.7)
T_{15}	Manual hoeing		20 & 40 DAS	8.1(64.0)	7.9(61.7)	7.8(61.0)	9.3(86.6)	11.4(128.5)	12.8(163.8)
T_{16}	Mechanical hoeing		20 & 40 DAS	8.2(67.0)	8.1(65.0)	8.1(64.0)	9.7(94.4)	11.8(138.5)	13.3(177.6)
T_{17}	Weedy check			12.1(146.3)	12.9(167.3)	10.7(113.3)	16.5(273.5)	23.4(547.3)	20.6(425.4)
T_{18}	Weed free			1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)
	CD at 5% level			0.5	0.5	0.4	0.9	1.1	1.2

Result and Discussion

The major weeds appeared in the experimental field at all the stages of observation were *Cyperus rotundus* among sedges, *Anagallis arvensis*, *Eclipta alba*, *Ageratum conyzodies*, *Coronopus didymus* among broad leaf weeds, *Brachiaria reptans* and *Dactyloctenium aegyptium as* grassy weeds.

All herbicidal treatments proved effective in controlling weeds density over weedy check at 40, 60 and 80 DAS (**Table 1**). Among herbicide treatments at 40, 60 and 80 DAS, density of weed was minimum and significantly less in

treatment alachlor 2000 g ha^{-1} as PRE *fb* tembotrione 120 g ha^{-1} + Surfactant. Atrazine 750 g ha^{-1} as PRE *fb* tembotrione 120 g ha^{-1} + S and tembotrione 140 g ha^{-1} + surfactant 1000 ml ha^{-1} being at par recorded lower density of weeds after alachlor 2000 g ha^{-1} *fb* tembotrione 120 g ha^{--1} in comparison to rest of the herbicide treatments. Tembotrione 120 g ha^{-1} + surfactant 1000 ml ha^{-1} and alachlor 2000 g ha^{-1}*fb* hoeing at 30 DAS being at par resulted in lesser weed density in comparison to weedy check and inter-cultural treatments. These results are in accordance with the findings of [4].

Among herbicide treatment, dry matter of weed at 40, 60 and 80 DAS was minimum and significantly lowest in treatment alachlor 2000 g ha^{-1} as PRE *fb* tembotrione 120 g ha^{-1} + Surfactant (Table 1). Atrazine 750 g ha^{-1} as PRE *fb* tembotrione 120 g ha^{-1} + S and tembotrione 140 g ha^{-1} + surfactant 1000 ml ha^{-1} being at par recorded lower dry matter of weeds at 60 and 80 DAS. Tembotrione 120 g ha^{-1} + surfactant 1000 ml ha^{-1} and alachlor 2000 g ha^{-1} *fb* hoeing at 30 DAS being at par resulted in reduced dry weight of weeds at all the stages of observation in comparison to weedy check. Similar results were reported by Owla [5] and Swetha [4].

Data mentioned in **Table 2** revealed that highest grain yield (7853 kg ha^{-1}) was recorded under weed free treatment. Alachlor 2000 g ha^{-1} as PRE *fb* tembotrione 120 g ha^{-1} + Surfactant, atrazine 750 g ha^{-1} as PRE *fb* tembotrione 120 g ha^{-1} + S, tembotrione 140 g ha^{-1} + surfactant 1000 ml ha^{-1} and treatment of tembotrione 120 g ha^{-1} + surfactant 1000 ml ha^{-1} produced grain yield at par with weed free check. These findings were substantiating with the result of Sunitha [6].

Table 2 Effect of weed control treatments on yield and economics of spring maize

Tr. No.	Treatments	Dose (g ha^{-1})	Time of Application	Grain yield (kg ha^{-1})	Gross returns (Rs. ha^{-1})	Total variable Cost (Rs. ha^{-1})	Return over variable cost (Rs. ha^{-1})	B:C ratio
T_1	Atrazine	750	PRE	5153	78239	43234	35005	1.81
T_2	Atrazine *fb* 2,4-D	750 & 500	PRE & 30 DAS	5523	84141	44304	39837	1.90
T_3	Atrazine *fb* one hoeing	750	PRE & 30 DAS	6027	91989	50130	41860	1.84
T_4	One hoeing *fb* atrazine	500	20 & 30 DAS	5813	88875	49703	39172	1.79
T_5	Alachlor	2000	PRE	6497	98351	43604	54747	2.26
T_6	Alachlor *fb* hoeing	2000	PRE & 30 DAS	6887	105045	50428	54617	2.08
T_7	Alachlor *fb* 2,4-D	1000 & 500	PRE & 30 DAS	6306	95563	44083	51480	2.17
T_8	Atrazine + alachlor	375 & 1000	PRE	6792	103658	44579	59080	2.33
T_9	Tembotrione + surfactant	120 + 1000	25 DAS	7214	109324	46023	63301	2.38
T_{10}	Tembotrione + surfactant	140 + 1000	25 DAS	7283	110832	46832	64000	2.37
T_{11}	Alachlor *fb* tembotrione + S	2000 & 120	PRE & 25 DAS	7648	116661	48456	68205	2.41
T_{12}	Metribuzin	400	PRE	4878	74214	43298	30916	1.71
T_{13}	Metribuzin	500	PRE	4819	73353	43612	29741	1.68
T_{14}	Atrazine *fb* tembotrione+ S	750 & 120	PRE & 25 DAS	7521	114307	48268	66039	2.37
T_{15}	Manual hoeing		20 & 40 DAS	5744	88358	54654	33704	1.62
T_{16}	Mechanical hoeing		20 & 40 DAS	5663	87175	43367	43808	2.01
T_{17}	Weedy check			4101	62870	40877	21993	1.54
T_{18}	Weed free			7853	119149	61735	57414	1.93
	CD at 5% level			640				

Data presented in Table 2 revealed that among herbicidal treatments, higher gross returns (Rs. 116661 ha^{-1}) and return over variable cost (Rs. 68205 ha^{-1}) were recorded in plots treated with alachlor 2000 g ha^{-1} as PRE *fb* tembotrione 120 g ha^{-1} + S followed by atrazine 750 g ha^{-1} as PRE *fb* tembotrione 120 g ha^{-1} + S (Rs. 114307 ha^{-1}) and (Rs. 66039 ha^{-1}), tembotrione 140 g ha^{-1} + surfactant 1000 ml ha^{-1} (Rs. 110832 ha^{-1}) and (Rs. 64000 ha^{-1}) and tembotrione 120 g ha^{-1} + surfactant 1000 ml ha^{-1} (Rs. 109324 ha^{-1}) and (Rs. 63301 ha^{-1}). Among herbicide treatments, metribuzin 400 g ha^{-1} PRE and metribuzin 500 g ha^{-1} PRE being at par recorded lower gross returns and return over variable cost *i.e.* Rs. 74214 and 30916 ha^{-1} and 73353 and 29741 ha^{-1} respectively. Similar results have been reported by Walia [7]. The highest B: C ratio (2.41) was computed under alachlor 2000 g ha^{-1} as PRE *fb* tembotrione 120 g ha^{-1} + Surfactant which was followed by tembotrione 120 g ha^{-1} + surfactant 1000 ml ha^{-1} (2.38), tembotrione 140 g ha^{-1} + surfactant 1000 ml ha^{-1} (2.37) and atrazine 750 g ha^{-1} as PRE *fb* tembotrione 120 g ha^{-1} + S (2.37). The lowest B: C

ratio among herbicidal treatments was found under metribuzin 500 g ha^{-1} PRE (1.68) and metribuzin 400 g ha^{-1} PRE (1.71).

Conclusion

It is concluded that among the herbicide treatments, alachlor 2000 g ha^{-1} as PRE *fb* tembotrione 120 g ha^{-1} + Surfactant was found to be most effective for controlling complex weeds in term of weed density and dry matter, grain yield, net return and B: C ratio.

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