

Original Research Article

<https://doi.org/10.20546/ijcmas.2018.704.150>

Weed Management in Maize System in New Alluvial Zone of West Bengal, India

Sonali Biswas^{1*}, Srabani Debnath², Abhijit Saha³ and Benukar Biswas⁴

¹Department of Agronomy, AICRP on Maize, Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia-741235, West Bengal, India

²Department of Pathology, AICRP on Maize, Directorate of Research, Bidhan Chandra Krishi Viswa vidyalaya, Nadia, West Bengal, India

³Department of Agronomy, College of Agriculture, Lembucherra, West Tripura, Tripura, India

⁴Department of Agronomy, Department of Agronomy, Bidhan Chandra Krishi Viswa vidyalaya, Nadia, West Bengal, India

*Corresponding author

ABSTRACT

A field experiment was conducted to evaluate the options of best weed management practices in maize-wheat cropping system during *kharif* season, 2015 and 2016 at the District seed farm, (AB Block), Kalyani, Bidhan Chanra Krishi Viswavidyalaya, Nadia, and West Bengal. In maize field, lowest number of weeds per m² and weed dry weight per m² were observed in weed free check and significantly lower number of weeds per m² and weed dry weight per m² were obtained with pre-emergence application of Atrazine @ 1.5 kg a.i/ha fb (followed by) Tembotrione (Laudis) 120 g a.i/ha POE (post emergence) at 25 DAS (T₁₀ treatment) which was statistically at par with T₉ treatment (pre-emergence application of pendimetalin @ 1000 ml/ha fb Atrazine @ 750 g a.i/ha + 2, 4-D Amine @ 0.4 kg a.i/ha at 25 DAS) as POE during the both years. During both the years, it was observed that highest maize grain yield, cob yield and system productivity in term of maize equivalent yield were obtained in weed free check which was statistically at par with treatment receiving Atrazine @ 1.5 kg a.i/ha fb Tembotrione (Laudis) 120 g a.i/ha POE at 25 DAS during first year of experimentation and which was closely followed during second year of experimentation. During the first year of experimentation (2015) highest net return and B: C ratio was obtained in treatment T₉ which was at par with T₁₀ treatment. During second year of experimentation (2016) highest net return (Rs.100043/-) was recorded in weed free check followed by sequential application of Atrazine @ 1.5 kg a.i/ha as pre emergence fb Laudis 120 g a.i/ha as POE application (96,452/-).

Keywords

Maize, Grain yield,
Weed management,
Net return

Article Info

Accepted:

12 March 2018

Available Online:

10 April 2018

Introduction

Maize (*Zea mays* L.) is one of the most important among the cereal crops in the world agricultural economy both as food and fodder

crop and is regarded as queen of cereals. It is one of the most versatile cereal crops having wider adaptability under diverse soil and climatic condition. In India, productivity of maize is low as compared to world which can

be attributed to several limiting factors and all but the most important amongst these has been the poor weed management which poses a major threat to crop productivity. Maize being a wider spaced crop with slow early growth, favours the growth of weeds even before crop emergence. Presence of weeds reduces the photosynthetic efficiency, dry matter production and distribution to economical parts and there by reduces sink capacity of crop resulting in poor grain yield. In India, the presence of weeds, in general reduces the maize yield by 27-60%, depending upon the growth and persistence of weed population in maize crop (Tripathi *et al.*, 2005, Jat *et al.*, 2012, Singh *et al.*, 2015, Kumar *et al.*, 2012).

Porwal (2000) observed that in the rainy season, emergence of maize and weeds were simultaneous and found that the first 20-30 days were the most critical period of competition for the crop. During this critical period weeding is essentially required by chemical and non-chemical means. Weeding by hand (labour) and mechanical means are expensive, time consuming, labour intensive and many a times timely operations are not possible due to continuous rains in monsoon season.

Herbicides are one of the crucial factors in a worldwide increase in cereal production. Clearly the farmer using herbicides in maize production is saving money or effort on mechanical weed control. There is an environmental benefit too in reduced use of fossil fuels and reduced soil disturbance in no till system representing a common benefit to us all. There are different categories of herbicides used in maize/maize based cropping system to manage weeds based on the time of application of herbicides viz. pre emergence herbicides, early post-emergence and post-emergence herbicides. Usage of pre-emergence herbicides assumes greater importance in the view of their effectiveness

from initial stages. Atrazine, pendimethalin, alachlor and oxadiargyl are some of the mostly used pre-emergence herbicides applied in maize based systems.

Atrazine and other herbicides recommended as a pre-emergence herbicides, is not effective against some of the weeds, both grassy and non-grassy as well as the sedges. Also, sometimes farmers skip the application of pre-emergent herbicides and also due to the scarcity of labour at that time, there is left no other alternative to control the weeds emerging during later stages. However, recently a pigment synthesis inhibitor tembotrione, which is post-emergent broad spectrum systemic herbicide of triketone group has been tested and proved to successful in managing all the categories of weeds infesting the maize field during the later stages (Singh *et al.*, 2012) and also increasing the yield of crop succeeding season (wheat) due to herbicides residue left over and ultimately reducing the pollution hazard. So, the present investigation was carried out to find out the best promising herbicide/herbicides combination to control all kinds of weeds in maize and their effect on succeeding wheat crop grown under sequential cropping.

Materials and Methods

A field experiment was conducted during *kharif* and *rabi* seasons of 2015-16 and 2016-17 in maize-wheat cropping sequence at the district seed farm, (AB Block), Kalyani, Bidhan Chanra Krishi Viswavidalaya, Nadia, West Bengal. The site situated at an attitude of about 9.75 m above mean sea level at 22°57' N latitude and 88°20' E longitude. The soil was silty clay loam in texture having pH 7.32, medium in organic carbon (0.53 %), available N 145.28 kg/ha, available P 28.82 kg/ha and available K 282.24 kg/ha. The experiment was laid down in RBD design with three replication and consists of ten (10) weed

management practices viz. T₁: Control (weedy check), T₂: Weed free, T₃: Atrazine @ 1.5 kg a.i/ha as pre-emergence, T₄: Atrazine (750 g a.i /ha) + pendimethalin (750 ml a.i/ha) as pre-emergence, T₅: Atrazine (1.5 kg a.i/ha) pre-emergence fb 2,4-D Amine (400 ml a.i/ha) at 25 DAS as post emergence, T₆: Halosulfuron @ 90 g/ha at 25 DAS, T₇: Atrazine (1.5 kg a.i/ha) pre-emergence fb Halosulfuron (90 g/ha) at 25 DAS as post emergence, T₈: Tembotrione (120 ml a.i/ha) at 25 DAS as post emergence, T₉: Pendimethalin (1000 ml a.i/ha) pre-emergence fb Atrazine (750 g a.i/ha) + 2,4-D Amine (400 ml a.i/ha) at 25 DAS as post emergence and T₁₀: Atrazine (1.5 kg a.i/ha) pre-emergence fb Tembotrione (120 ml a.i/ha) at 25 DAS as post emergence. Maize variety P 3377 was sown manually at spacing of 60 cm x 20 cm using 20 kg seed /ha in (2015 and 2016), respectively and fertilizer with 150:60:60 (N, P₂O₅ and K₂O kg/ha). Both P and K and 1/3 dose of Nitrogen were applied at the time of sowing and remaining N was applied in two equal splits doses at knee height and tasseling stages. Herbicidal treatments were applied as per treatments and spraying was done with the help of Knapsack sprayer fitted with a flat fan nozzle with the spray volume of water 600 ml/ha. Weed population was taken by quadrat method and dry weight was done as per standard method. The density and weed dry weight were analyzed after subjecting the original data to square root transformation $[\sqrt{x+0.5}]$. The treatment effects were compared using transformed means.

The succeeding wheat crop variety PBW 343 was sown on middle of November during both the years of study (2015 and 2016), respectively. The wheat crop was fertilized with 40:60: 40 (N, P₂O₅ and K₂O kg/ha) at sowing and remaining 40 kg N/ha was top dressed in two equal doses at CRI and flowering stages. All other practices were followed as per recommendations for wheat.

System productivity in term of maize equivalent yield was calculated by adding the grain yield of maize with maize equivalent yield of wheat calculated by using the following formula:

$$\text{Maize equivalence (Kg/ha)} = \frac{\text{Total price of produce to be compared}}{\text{Price of maize kg}^{-1}}$$

The yield parameters and yields were recorded and analyzed as per Gomez and Gomez (1984). The treatment comparisons were made using t-test at 5 % level of significance. The economies were calculated on the basis of prevailing local market price of maize grains and cost of inputs.

Results and Discussion

Effect on weed population and weed dry weight

The weed population and dry weight of weeds in maize (Table 1) significantly reduced in the herbicide treatments. The data on weed count and dry weight revealed that, lowest weed number and weed dry weight was observed in weed free treatment but highest weed population and dry weight of weeds recorded in weedy check. Among weed management, significantly lower weeds population and dry matter production of weeds were recorded with pre-emergence application of atrazine @ 1.5 kg a.i/ha fb Tembotrione (Laudis) 120 g a.i/ha as POE at 25 DAS which was statistically at par with T₉ treatment (pre-emergence application of pendimethalin @ 1000 ml/ha fb atrazine @ 750 g a.i/ha + 2, 4-D Amine @ 0.4 kg a.i/ha at 25 DAS as post emergence application). It may be due to the lowest population of grassy and non-grassy weeds in this treatment. Singh *et al.*, found most effective to control the grassy as well as non-grassy weeds as compared to other herbicidal treatments.

Table.1 Effect of weed management on yield and system productivity

Treatment	Maize grain yield (kg/ha)		Cob Yield (kg/ha)		Wheat Yield (kg/ha)		System Productivity (kg/ha)	
	2015	2016	2015	2016	2015	2016	2015	2016
T₁	2525	7061	8300	7965	1444.3	3445.67	4191.5	11421.96
T₂	4135	11829	21120	12735	3011.3	6031.00	7609.2	16478.67
T₃	3704	7197	19769	8072	1767.3	4177.00	5743.2	12417.91
T₄	3525	7183	18896	8147	1573.0	4237.67	5340	12479.86
T₅	3672	7670	20281	8539	1666.3	4394.67	5594.7	1310.72
T₆	2734	7107	11329	7967	1799.7	3494	4810.5	11474.37
T₇	3806	7201	20314	8096	1504.3	3999.33	5541.8	12199.72
T₈	3284	7308	17813	8156	1817.7	4374.33	5381.3	12775.82
T₉	3889	11370	22385	12367	2566.3	4936	6850.2	14610.33
T₁₀	3969	11529	22154	12514	2699.3	5463	7030.6	15623.33
CD (p=0.05)	213	162.6	263	132.8	613.34	543	688.39	832.46

Table.2 Effect of weed management on economics

Treatments	Net Return (Rs./ha)		B:C ratio	
	2015	2016	2015	2016
T₁	8300	42838	1.40	2.02
T₂	21120	100043	1.74	3.38
T₃	19769	45540	1.80	2.07
T₄	18896	44293	1.81	2.05
T₅	20281	50143	1.85	2.19
T₆	11329	43382	1.53	2.03
T₇	20314	44507	1.80	2.06
T₈	17813	45795	1.82	2.09
T₉	22385	94544	1.92	3.25
T₁₀	22154	96452	1.87	3.30
CD (p=0.05)		2302.1		0.1

Table.3 Effect of weed management on weed population and weed dry weight during 2015

Treatments	No. of weeds / m ² at harvest			Weed dry weight / m ² at harvest (g)		
	Grass	Sedge	BLW	Grass	Sedge	BLW
T ₁	233.83 (15.31)	169 (13.01)	116.7 (10.82)	27.55 (5.30)	19.16 (4.43)	16.61 (4.13)
T ₂	0.0(0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)	0.0 (0.71)
T ₃	94.67 (9.74)	87.33 (9.35)	62.4 (7.91)	12.27 (3.57)	10.67 (3.33)	7.13 (2.76)
T ₄	110.33 (10.52)	97.66 (9.88)	63.3 (7.98)	14.35 (3.85)	11.56 (3.46)	8.15 (2.93)
T ₅	112.67 (10.63)	98.0 (9.92)	62.4 (7.92)	15.03 (3.93)	11.71 (3.48)	8.05 (2.92)
T ₆	152.5 (12.36)	109.0 (10.45)	109.2 (10.46)	17.69 (4.26)	13.81 (3.78)	14.07 (3.82)
T ₇	90.67 (9.54)	93.66 (9.70)	65.4 (8.10)	12.61 (3.62)	11.68 (3.49)	8.91 (3.06)
T ₈	109.67 (10.49)	107.33 (10.37)	71.4 (8.44)	15.03 (3.94)	12.40 (3.59)	8.89 (3.06)
T ₉	95.83 (9.80)	92.33 (9.63)	64.8 (8.08)	13.72 (3.77)	11.58 (3.46)	8.44 (2.98)
T ₁₀	86.5 (9.32)	83.33 (9.15)	51.3 (7.19)	11.17 (3.41)	10.09 (3.25)	6.36 (2.61)
CD (p=0.05)	0.86	1.07	1.06	0.33	0.5	0.4

The data were transformed before statistical analysis using square root transformation [$\sqrt{x+0.5}$]. Figures in parenthesis are the original value for respective data.

Table.4 Effect of weed management on weed population and weed dry weight during 2016

Treatment	No of grass/m ² (At harvest)	No of sedges/m ² (At Harvest)	No of broadleaves/m ² (At Harvest)	Dry weight of grassy weeds/m ² (At Harvest)	Dry weight of sedges/m ² (At Harvest)	Dry weight of broadleaf/m ² (At Harvest)
T ₁	13.2(173.9)	10.2(103.3)	7.3(53.3)	7.8(59.8)	4.1(16.5)	3.7(13.2)
T ₂	0.7(0.0)	0.7(0.0)	0.7(0.0)	0.7(0.0)	0.7(0.0)	0.7(0.0)
T ₃	12.3(152.2)	7.9(61.3)	6.3(39.2)	6.5(41.3)	3.4(11.2)	3.4(11)
T ₄	12.3(149.9)	8.0(62.6)	5.3(27.2)	6.2(38.1)	3.7(13.4)	3.5(11.4)
T ₅	10.8(116.2)	7.3(53.4)	5.4(28.7)	6.0(35.6)	3.0(8.7)	3.3(10.1)
T ₆	12.7(160.6)	8.6(73.4)	5.8(33.4)	6.8(46.2)	3.6(12.5)	3.5(12.1)
T ₇	11.8(139.5)	7.5(55.3)	5.3(27.8)	6.2(38.3)	2.8(7.6)	3.3(10.6)
T ₈	12.1(145.8)	8.2(66.1)	5.6(30.7)	6.4(40.7)	3.4(10.7)	3.3(10.6)
T ₉	9.8(95.9)	7.4(38.8)	5.2(26.7)	4.8(23.1)	2.7(6.9)	2.8(7.3)
T ₁₀	8.6(73.5)	7.2(51.6)	4.3(17.6)	4.4(18.6)	2.3(4.7)	2.4(5.4)
CD (p=0.05)	0.1	0.1	0.2	0.2	0.5	0.0

The data were transformed before statistical analysis using square root transformation [$\sqrt{x+0.5}$]. Figures in parenthesis are the original value for respective data.

Effect on yield

Maize

During both the years, it was observed that highest maize grain yield and cob yield was obtained in weed free check. Among the weed control treatments, sequential application of atrazine @ 1.5 kg a.i/ha fb tembortrion @ 120 g a.i/ha recorded higher maize grain yield (3969 kg/ha and 11529 kg/ha in 2015 and 2016, respectively) which was statistically at par with T₉ treatment [pre-emergence application of Pendimethalin (1000 ml a.i/ha) fb Atrazine (750 g a.i/ha) + 2,4-D Amine (400 ml a.i/ha) at 25 DAS as POE]. The higher grain and cob yield in these treatments could be attributed to improved yield components such as higher number of grains cob⁻¹, higher grain row cob⁻¹, higher grain weight cob⁻¹ and 100 grain weight. Thus, the improvement in yield component was as a consequence of lower crop-weed competition, which shifted the balance in favour of crop in the utilization of nutrients, moisture, light and space. The results are supported with the findings of Angiras (1998) and Kamble *et al.*, (2005).

Wheat

During the first year (2015-16) of experimentation lower yield of maize was obtained ranging from 2525 kg/ha in weedy check to 4135 kg/ha in weed free plots along with low yield of succeeding wheat ranging from 144.3 kg/ha in weedy check to 3011.3 kg/ha in weed free check. This is may be due to low nutrient availability of soil that depleted by the *kharif* maize.

During the second year (2016-17) of experimentation higher yield of wheat was obtained ranging from 3445.67 kg/ha in weedy check to 6031.00 kg/ha in weed free check and T₁₀ treatment also recorded higher wheat yield (5463 kg/ha). This is might be

due to positive residual effect of applied nutrient of preceding *kharif* maize in cropping system.

System productivity

During both the year of experimentation highest system productivity (76092.2 kg/ha) was revealed in weed free plots which was statistically at par with treatment T₁₀ (7030.6 kg/ha) during first year of experimentation and which was closely followed by treatment T₁₀ (15623.33 kg/ha) during second year of experimentation. This is mainly due to higher grain yield of both maize and wheat that attributed by lower crop-weed competition along with improved growth and yield components in weed free check and in treatment T₁₀ which receiving atrazine @ 1.5 kg a.i/ha fb tembortrion 120 g a.i/ha as POE (Sreenivas and Satyanarayana, 1994).

Economies

From the data of net return and B: C ratio showed that there was significant variation in the net return and B: C ratio produced in maize-wheat system due to direct and residual effect of different weed control treatments. During the first year of experimentation (2015-16) highest net return and B: C ratio was obtained in treatment T₉ which was at par with T₁₀ treatment. During second year of experimentation (2016-17) highest net return (100043/-) was recorded in weed free check followed by sequential application of Atrazine @ 1.5 kg a.i/ha fb Laudis 120 g a.i/ha as POE application (RS. 96,452/-). This was due to higher gross return, lower cost of cultivation and higher economic yield of maize (Table 2).

From the above study, it can be concluded that hand weeding, though an effective operation, it is time consuming and labour intensive, expensive, impractical to perform under odd soil condition and at early

vegetative stages. So, sequential application of Atrazine @ 1.5 kg a.i/ha as pre-emergence fb Tembotrion @120 g a.i/ha as post emergence application in maize-wheat system in New Alluvial zone during *kharif* will not only increased productivity, net return but also providing an option of economical weed management.

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How to cite this article:

Sonali Biswas, Srabani Debnath, Abhijit Saha and Benukar Biswas. 2018. Weed Management in Maize System in New Alluvial Zone of West Bengal, India. *Int.J.Curr.Microbiol.App.Sci*. 7(04): 1344-1350. doi: <https://doi.org/10.20546/ijcmas.2018.704.150>