International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(4): 1131-1134

Received: 21-05-2019
Accepted: 24-06-2019

Suman Agrawal
Department of Agronomy, BAU, Bhagalpur, Bihar, India

Sanjay Kumar
Department of Agronomy, BAU, Bhagalpur, Bihar, India

Durgesh Singh
Department of Agronomy, BAU, Bhagalpur, Bihar, India

Swaraj Kumar Dutta
Department of Agronomy, BAU, Bhagalpur, Bihar, India

Sunil Kumar
Department of Agronomy, BAU, Bhagalpur, Bihar, India

Correspondence
Suman Agrawal
Department of Agronomy, BAU, Bhagalpur, Bihar, India

Growth and yield enhancement of *rabi* maize through identification of best timing for herbicide application

Suman Agrawal, Sanjay Kumar, Durgesh Singh, Swaraj Kumar Dutta and Sunil Kumar

Abstract
Maize (*Zea mays* L.) as a highly productive crop mostly influenced by weeds, that can reduce the yield about 25 to 90 % which is much more than the other losses. In this contests to assess the best weed management practice this experiment entitled "effect of application timing of chemical herbicides on weed control efficacy and productivity of *rabi* maize (*Zea mays* L.)" was conducted during *rabi* season of 2017-18 at Research farm of BAU, Bhagalpur. The experiment was laid out in split plot design with three replications having 18 treatment combinations consisted of three as pre emergence (main plot) and six as post emergence (sub plot). The application of atrazine 1000 g a.i. ha^{-1} (PE) *fb* tembotrione 120 g a.i. ha^{-1} + atrazine 500 g a.i. ha^{-1} (PoE) significantly increases the LAI, dry weight, number of cobs $plant^{-1}$, cob length, cob weight, number of grains cob^{-1} and grain yield of maize. So it may conclude that the that application of atrazine 1000 g a.i. ha^{-1} as PE *fb* tembotrione 120 g a.i. ha^{-1} + atrazine 500 g a.i. ha^{-1} as PoE may enhance the growth and yield by effective weed control which can increase the benefits of farmers growing *rabi* maize.

Keywords: *Zea mays* L. enhancement identification

Introduction
In agronomy language maize (*Zea mays* L.) is commonly known as "Queen of cereals" due to its high productivity potential than the other cereals. Maize is the third most important grain crop (after rice and wheat) in India with respect to area and productivity (Anonymous, 2015). In India, Uttar Pradesh, Rajasthan, Madhya Pradesh, Bihar, Himachal Pradesh, Jammu & Kashmir and Punjab are major maize producing states, which together account for 2/3rd of the total area and production. In India: *Kharif*, *rabi* (peninsular India and Bihar), *spring* (North India) are three seasons when maize is grown. Maize mainly as a *kharif* season crop but from past few years *rabi* maize has gained significant place in total maize production in India. *Rabi* maize was first introduced on farmer's field of Bihar in 1961, when double crop hybrids of maize grown on an experimental basis in *kharif* season failed to produce to the expectation. The reason for failure in obtaining good yield was incident of heavy rainfall during the crop period which is a usual incident of *kharif* season. In *Rabi*, it is sown in October-December in Bihar, Punjab and coastal region of Andhra Pradesh, Karnataka and Uttar Pradesh, as it is grown throughout the year due to its photo-thermo-insensitive character and highest genetic yield potential among the cereals. *Rabi* maize gives better results as the crop remains free from incidence of insects, pests and diseases and slower growth of weeds in addition to higher yield above the expectation compared to *kharif* maize. *Rabi* maize technology was widely accepted by farmers of Bihar which later caught the attention of other states where it being successfully grown now. Cultivation area of *rabi* maize is about 1.2 mha with the economic production of 5.08 mt and average productivity is about 4.0 t ha^{-1}. The largest *rabi* maize growing states are Andhra Pradesh (45.4 %), Bihar (20.2 %), Tamilnadu (9.2 %), Karnataka (8.5 %), Maharashtra (7.8 %) and West Bengal (5.4 %) (Das, 2008). Being a C_4 plant, it has capacity to utilize solar radiation in more efficient way even at higher radiation intensity. Amongst all losses, weeds account for 28 to 100 % yield loss (Pandey *et al*. 2001, Das *et al*. 2012) [9, 3] which is higher than the losses due to animal pests (18%), fungal and bacterial pathogens (16%) and viruses (2%) (Tesfay *et al*., 2014) [11]. Weeds provide competition to crop plants for light, space, water and nutrients.

Weeds also exudates substances from roots and leaves which are toxic to crop plants. This causes severe interference with normal crop growth, leading to reduction in yield and quality. So by the above problems a large gap between potential and actual yield of maize have been seen (Khan *et al.*, 2003) [7]. Each herbicide has its own spectrum of weed control which leads to its efficacy and use in the field. Nevertheless, farmers are applying single herbicides like atrazine as pre emergence and to certain extent 2,4-D Na salt for controlling weeds at present, is not effective against some of the weeds (both grassy and non-grassy as well as the sedge). So, new herbicides *viz.* Tembotrione 34.4 SC with broad spectrum of weed control is highly essential for effective control of different classes of weed like grasses, sedges and broad leaved weeds. Hence, the present study was carried out to find out the effect of new herbicides on growth and yield of *rabi* maize.

Material and Methods

Experimental site

A field experiment was conducted during *rabi* season 2017-18 at Crop Research Farm, Department of Agronomy, Bihar Agricultural University, Bhagalpur, Bihar, located between 25º 50' N latitude and 87º19' longitude at an altitude of 52.73 meter above mean sea-level. The soil of the experimental site was loamy sand having pH 7.8, electrical conductivity 0.39 dS m^{-1} and 220.4 kg N, 35.3 kg P and 325 kg K per ha.

Climatic and Weather Conditions of Research Site

Climate of Sabour, Bhagalpur is sub-tropical, hot desiccating summer, cold winter and moderate rainfall. December and January are usually the coldest month where the mean temperature normally fall as low as 8.8^{0}C whereas; May and June are the hottest months, having the maximum average temperature of 36.1°C. The average annual rainfall is about 1250 mm precipitating mostly between middle of June to middle of October. Mean weekly weather data during the experimentation have been given in fig 1.

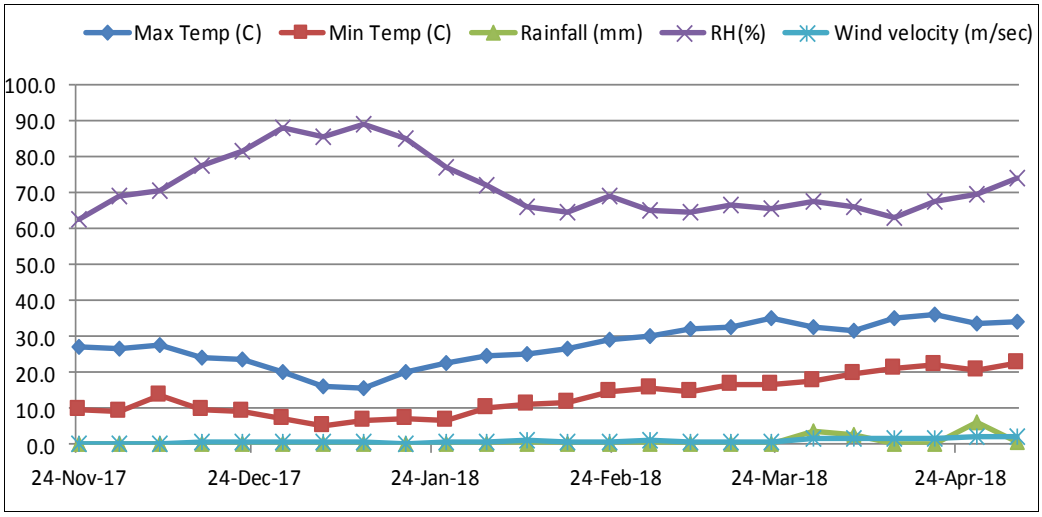

Fig 1: Weekly meteorological observations during crop growth period (From 24 Nov, 2017 to 4th May, 2018)

Experimental details

Experiment was conducted in the split plot design with three replications and size of experimental plot was 18 m^2. Sowing of *rabi* maize was done (24 November) under irrigated condition, with spacing 50 cm x 20 cm (row to plant) and fertilizer dose was 150: 75: 60: (N: P_2O_5: K_2O Kg ha^{-1}). In this experiment 18 treatment combinations; three pre-emergence *viz*. No Pre-emergence (PE_1), Pendimethalin (PE_2) @ (1000 g a.i. ha^{-1}) and Atrazine (PE_3) @ (1000 g a.i. ha^{-1}) as main plot, six as post-emergence *viz*. No Post-emergence (PoE_1), Atrazine @ (500 g a.i. ha^{-1}) (PoE_2), Tembotrione @ (120 g a.i. ha^{-1}) (PoE_3), Halosulfuron @ (90 g a.i. ha^{-1}) (PoE_4), Tembotrione @ (120 g a.i. ha^{-1}) + Atrazine @ (500 g a.i. ha^{-1}) (PoE_5), Halosulfuron @ (90 g a.i. ha^{-1}) + Atrazine @ (500 g a.i. ha^{-1}) (PoE_6) as sub plot treatment.

Result and Discussion

Effect on Growth

Growth of maize measured in terms of height (cm), leaf area Index (LAI) and dry matter accumulation (kg ha^{-1}) was significantly influenced by different weed control treatments. Data presented in Table 1 have been clearly shows that the plant height of crop was progressively increase over the time, the highest plant height (210 cm) was recorded in the treatment atrazine 1000 g a.i. ha^{-1} as PE *fb* tembotrione 120 g a.i. ha^{-1} + atrazine 500 g a.i. ha^{-1} as PoE which was significantly higher than the other treatment. However, the lowest plant height was obtained with no pre and no post-emergence herbicides. Maximum dry matter accumulation of maize (19142 kg ha^{-1}) was also from the same treatment. This might be due to weed free environment that leads to the minimum crop weed competition from the initial stage of plant growth. The data on leaf area index (LAI) at different growth stages from 30 DAS to 120 DAS (fig. 2) of maize tended to increased progressively with advance in the age of the crop till 90 DAS and after that slightly decrement was recorded. Among pre-emergence herbicides LAI was recorded significantly higher (4.75) with atrazine 1000 g a.i. ha^{-1} which was statistically at par with pendimethalin. In sub plot highest LAI (4.84) was recorded with tembotrione + atrazine. Similar results are found to be in close compliance With Arvadia *et al*. (2012) [2]. No pre-emergence *fb* no post-emergence recorded lower dry matter addition in maize crop due to lower growth components which are important indices of plant that determines the photosynthetic ability, growth and dry matter production. Similar results are reported by Kamble *et al.*, 2005; Williams *et al.*, 2011; Ishrat *et al.*, 2012. [6, 13, 5]

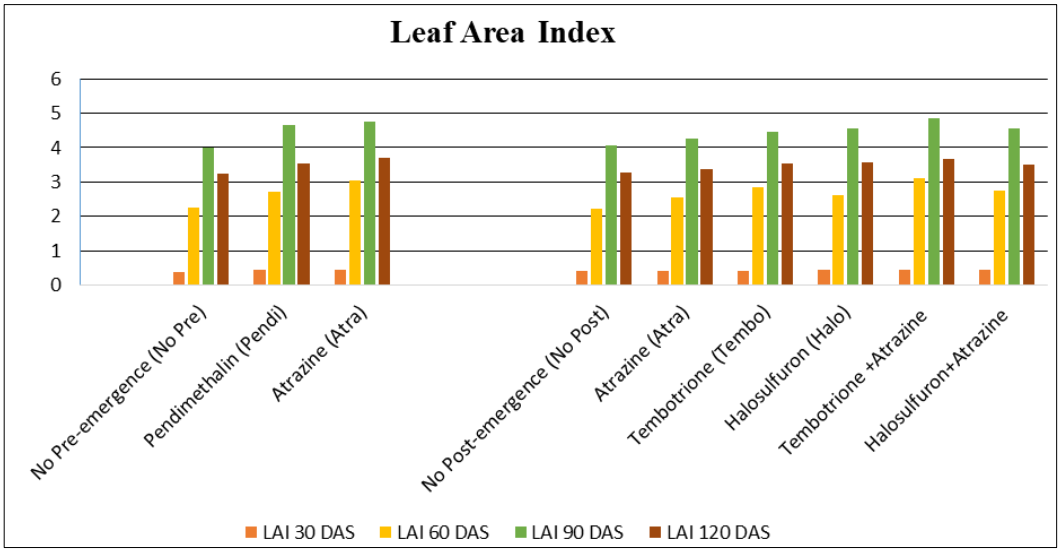

Fig 2: Leaf Area Index of *rabi* maize as influenced by application of different pre and post emergence herbicides

Effect on yield attributes

Main plot treatment did not influence the number of cobs plant^{-1} of maize but due to sub plot treatment significantly higher cobs plant^{-1} (1.2) was recorded with Tembotrione (120 g a.i. ha-1) + Atrazine (500 g a.i. ha^{-1}) which is at par with all other sub plot treatment except no post-emergence herbicide application. Data on cob length of maize revealed that there was significant influence of main plot treatment, atrazine 1000 g a.i. ha^{-1} as pre-emergence gives significantly higher cob length (17.2 cm) which is at par with pendimethalin 1000 g a.i. ha^{-1}. Due to sub plot treatment cob length was recorded significantly higher with Tembotrione (120 g a.i. ha-1) + Atrazine (500 g a.i. ha^{-1}) (17.2 cm). The data on cob weight of maize recorded maximum cob weight (330 g) with atrazine 1000 g a.i. ha^{-1} as pre-emergence which was significantly higher over no pre-emergence herbicide treatment and at par with pendimethalin 1000 g a.i. ha^{-1}. Whereas in sub plot treatment cob weight was recorded significantly higher with Tembotrione (120 g a.i. ha-1) + Atrazine (500 g a.i. ha^{-1}) (335 g) which is at par with all other sub plot treatments except sole atrazine 500 g a.i. ha^{-1} and no post-emergence. Interaction effect of all the treatments combinations on yield attributing characters was found non-significant (Williams *et al.*, 2010) [12]

Effect on yields

Data pertaining in Table 2 revealed that the maximum grain yield (8536 kg ha^{-1}) in treatment where atrazine 1000 g a.i. ha^{-1} as pre-emergence was applied which was significantly higher over no pre-emergence herbicide application and at par with pendimethalin 1000 g a.i. ha^{-1}. Among the post-emergence application of tembotrione + atrazinen gave 47% more yield than no post-emergence application. The maximum grain yield was recorded by with tembotrione + atrazinen while the minimum was recorded by no post-emergence. Among post-emergence herbicides stover yield was obtained maximum with halosulfuron which was statistically at par with atrazine, tembotrione + atrazinen, halosulfuron + atrazinen and lowest stover yield was recorded with no post-emergence herbicide. This might be due to efficient and broad spectrum herbicidal weed control achieved by the above treatments resulted utilization of nutrients and other growth factors resulting in higher yield. The results are in concordance with the findings of Larbi *et al.*, 2013; Singh *et al.*, 2012. [8, 10]

Table 1: Growth and yield attributes of maize as influenced by application of different pre and post emergence herbicides.

Treatment	Plant Height (cm)	Dry Weight (g)	No. of cobs per plant	No. of grains Per cob	No. of rows per cob	No. of grains per row of cob	100 grain Weight (g)	Girth of Cob (cm)
No Pre-emergence (No Pre)	200	15940	1.1	319	14.3	22.86	24.62	14.5
Pendimethalin	200	17883	1.2	328	14.4	23.47	25.69	14.6
Atrazine	206	18587	1.2	339	14.2	23.83	26.00	15.1
S.Em (±)	3.62	276	0.01	4.46	0.08	0.18	0.37	0.15
CD at 5%	NS	1083	NS	NS	NS	0.72	NS	NS
No Post-emergence (No Post)	177	13396	1.0	284	14.0	21.84	23.08	14.7
Atrazine	207	17396	1.2	342	14.0	24.26	24.50	14.5
Tembotrione	209	18152	1.2	338	14.4	24.36	26.14	14.7
Halosulfuron	202	18032	1.1	329	14.2	23.94	25.77	14.8
Tembotrione +Atrazine	210	19142	1.2	343	14.7	23.11	26.90	14.7
Halosulfuron + Atrazine	206	18702	1.2	335	14.7	22.93	26.23	14.9
S.Em (±)	4.54	306	0.02	7.19	0.29	0.51	0.48	0.16
CD at 5%	13	884	0.1	21	NS	1.46	1.38	NS

Note: PE – Pre emergence, PoE – Post emergence, Pendi – Pendimethalin, Atra - Atrazine, Tembo – Tembotrione, Halo – Halosulfuron, *fb* – Followed by.

Table 2: Yields, harvest index and cob of maize as influenced by application of different pre and post emergence herbicides.

Treatment	Grain Yield (kg/ha)	Stover Yield (kg/ha)	Stone Yield (kg/ha)	Biological Yield (kg/ha)	Harvest Index (%)	Cob Length (cm)	Cob Weight (g)
No Pre-emergence (No Pre)	7393	6434	2113	15940	0.46	15.5	293
Pendimethalin	8258	7425	2200	17883	0.46	16.5	319
Atrazine	8536	7831	2220	18587	0.46	16.8	330
S.Em (±)	143	224	26	276	0.01	0.24	4.78
CD at 5%	561	879	NS	1083	NS	1.0	19
No Post-emergence (No Post)	5039	6419	1937	13396	0.38	15.5	259
Atrazine	8162	7222	2013	17396	0.47	16.2	312
Tembotrione	8873	7075	2204	18152	0.49	16.3	330
Halosulfuron	7803	8036	2192	18032	0.44	16.0	322
Tembotrione + Atrazine	9612	7220	2310	19142	0.50	17.2	335
Halosulfuron + Atrazine	8885	7407	2410	18702	0.48	16.3	326
S.Em (±)	153	307	24	306	0.01	0.23	5.65
CD at 5%	441	885	71	884	0.03	0.7	16

Note: PE – Pre emergence, PoE – Post emergence, Pendi – Pendimethalin, Atra - Atrazine, Tembo – Tembotrione, Halo – Halosulfuron, *fb* – Followed by.

Conclusions

Considering the losses caused by weeds in *rabi* maize and results obtained from one season data on different weed management practices, it may conclude that the maximum crop growth, yield attributing characters and yield of maize can obtain by better weed management through the application of atrazine 1000 g a.i. ha^{-1} (Pre-emergence) followed by tembotrione 120 g a.i. ha^{-1} + atrazine 500 g a.i. ha^{-1} (Post-emergence). These combination and timing of herbicide can provide maximum benefits to the *rabi* maize growers.

References

1. Anonymous Annual progress report *Kharif* 2015. ICAR, Indian Institute of Maize Research, Ludhiana, 2015.
2. Arvadiya LK, Raj VC, Patel TU, Arvadla MK. Influence of plant population and weed management on weed flora and productivity of sweet com (Zea mays). Indian journal of Agronomy. 2012; 57(2):162-167.
3. Das S, Kumar A, Jat SL, Parihar CM, Singh AK, Chikkappa GK *et al*. Maize holds potential for diversification and livelihood security. Indian Journal of Agronomy. 2012; 57:32-37.
4. Das TK. Weed Science: Basics and Application. Jain Brothers Pub, New Delhi, 1st Ed, 2008, 901.
5. Ishrat DH, Hunshal CS, Malligwad LH, Chimmad VP. Effect of pre and POE emergence herbicides on weed control in maize. Karnataka J Agric. Sci. 2012; 25(3):392-394.
6. Kamble TC, Kakade SU, Nemade SU, Pawar RV, Apotikar VA. A integrated weed management in hybrid maize. Crop Research Hisar. 2005; 29(3):396-400.
7. Khan MA, Marwat KB, Khan N, Khan IA. Efficacy of different herbicides on the yield and yield components of maize. Asian J Plant Sci. 2003; 2:300-304.
8. Larbi E, Ofosu-Anim J, Norman JC, Anim-Okyere S, Danso F. Growth and yield of maize (*Zea mays* L.) in response to herbicide application in the coastal savannah ecozone of Ghana. Net Journal of Agricultural Science. 2013; 41(3):81-86.
9. Pandey AK, Prakash V, Singh RD, Mani VP. Integrated weed management in maize. Indian Journal of Agronomy. 2001; 46:260-265.
10. Singh VP, Guru SK, Kumar A, Banga A, Tripathi N. Bioefficacy of tembotrione against mixed weed complex in maize. Indian Journal of Weed Science. 2012; 44(1):1-5.
11. Tesfay A, Amin M, Mulugeta N. Management of weeds in maize (*Zea mays* L.) through various pre and post emergency herbicides. Adv Crop Sci. Tech. 2014; 2:151.
12. Williams MM, Boerboom CM, Rabaey TL. Significance of atrazine in sweet corn weed management systems. Weed Technology. 2010; 24(2):139-142.
13. Williams MM, Boydston RA, Peachey RE, Robinson D. Significance of atrazine as a tank-mix partner with tembotrione. Weed Technology. 2011; 25(3):299-302.