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Effect of new generation herbicide molecules on growth and yield parameters of *rabi* maize (*Zea mays* L.)

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Abstract
A field experiment conducted during 2016 on Evaluation of new generation herbicides molecules on growth and yield of *rabi* maiz**e (***Zea mays* L.)" was conducted at College Farm, College of Agriculture, Professor Jayashankar Telangana State Agricultural University (PJTSAU), Rajendranagar, Hyderabad, during *rabi* 2016. The experiment was laid out in randomized block design with eight treatments replicated thrice. Growth and yield of maize was influenced by Atrazine @ 1kg *a.i* ha^{-1} + intercultural operations HW at 20 and 40 DAS followed by tank mix application of herbicides, topramezone 33.6% EC @ 25.2 g. ha^{-1} + dimethanamide 72%EC @600g *a.i* ha^{-1} (as early post emergent 10-12 DAS) (T_4).

Keywords: Maize, dry matter production and plant height

Introduction
Maize is the world's third most important cereal crop after wheat and rice and is grown for grain as well as fodder. It is also known as "queen of cereals" and now being referred as "king of cereals" due to its cosmopolitic nature and high productivity. The area of maize in all growing countries during the year 2016-17 is about 179 M ha with production and productivity of 101Mt (*Source:* www.geofin.co.in) and 5.5 Mt ha^{-1} respectively. It accounts for about 64% of coarse grain and 27.1 % of total cereal production (Commodity Profile on Maize, 2015). In India maize ranks 5th in area and 3rd in production and is being cultivated in an area 11.52Mha^{-1} with the production of 13.08 Mt and average productivity of 1640 kg ha^{-1}**.**(Source: Ministry of Agriculture, GOI June 2016**)** production of *Kharif* maize was higher by 4.05 million tonnes over the last year's production. In Telangana State, maize is cultivated in an area of 6.91 lakh ha with a total production of 23.08 lakh tons and productivity of 333.8kg ha^{-1} (Department of Agriculture and Cooperation, 2016) [2].

Maize has wider adaptability under diverse soil and climatic conditions and got a variety of uses hence, became popular among consumers for table purpose as it is being widely accepted for the same. There are many agronomic constraints for low productivity of maize in Telangana state. Among them weed infestation is one of the important limitation. Which inflict huge losses ranging from 28 to 100% in maize (Patel *et al*., 2006) [8] due to wider row spacing and initial slow crop growth (Nagalakshmi *et al*., 2006) [6] makes highly sensitive to weed competition during initial six weeks growth period. Thus, to realize optimum yields demands during initial six weeks of crop growth through weed management is considered critical for crop weed competition. Thus, chemical weed control assumes significance in the cultivation of the maize. There are very few herbicide options available for weed control in maize in India.

Currently, herbicides used for control of weeds include pre-emergence application of atrazine, simazine, pendimethalin, alachlor and post-emergent application of 2, 4-D. Most of these herbicides provide only a narrow spectrum weed control in maize. But Control of perennial weed spectrum remain a problem for the farmers, particularly when the too high or too low soil moisture interfere the intercultural operation. It is also well documented that continuous and persistence of atrazine in soil resulting in residual effects (Singh *et al*., 2012) [11].

Material and Method
A field experiment to study the Evaluation of New Generation Herbicide molecules on growth and yield of *rabi* Maize **(***Zea mays* L.)'' was carried out under field conditions during *rabi* 2016 at College Farm, College of Agriculture, Rajendranagar, Hyderabad, Telangana state. Soil of the experimental site was sandy loam in texture, low in available nitrogen,

medium in phosphorus and potassium. The experiment was laid out in randomized block design with three replications and eight treatments *viz.*, T_1 - Topramezone 33.6% EC @ 25.2 g ha^{-1} + Dimethanamide @ 570 g ha^{-1} (early post emergent)T_2 - Topramezone 33.6% EC @ 25.2 g ha^{-1} + Atrazine @ 50% WP (early post emergent)T_3 - Atrazine @1 kg *a.i* ha^{-1} followed by 2, 4-D @ 0.5 kg T_4 - Atrazine followed by Topramezone 33.6% EC @ 25.2 g. ha^{-1} + Dimethanamide 72%EC @ 600g *a.i* ha^{-1} (as early post emergent at 25 DAS).T_5 - Atrazine 1kg *a.i* ha^{-1} followed by Topramezone SC 33.6% @ 25.2 g. *a.i* ha^{-1} +Atrazine 0.5kg *a.i* ha^{-1} (as early post emergent at 25 DAS). T_6 - Atrazine (Pre-emergent) @ 1kg *a.i* ha^{-1} followed by Atrazine as post emergence @ 1kg *a.i* ha^{-1} T_7 - Atrazine @ 1kg *a.i* ha^{-1} followed by intercultural operations and hand weeding at 20 and 40 DAS.T_8 - Unweeded control. Maize hybrid (DHM-117) was sown on October 26th, 2016 with a spacing of 60 cm x 20 cm. The recommended dose of fertilizers @ 180-60-60 kg of N- P_2O_5 - K_2O ha^{-1} in the form of Urea, DAP and MOP was applied to all treatments The data on Growth and yield parameters viz, Plant height, Dry matter production (30, 60, 90 DAS and at maturity), yield attributes, stover and grain yield and harvest index were recorded in *rabi* maize during year of study.

Result and Discussion

Plant height

During year of study plant height at 30 days after sowing was recorded with application of atrazine @ 1kg *a.i* ha^{-1} +intercultural operations and hand weeding at 20 and 40 DAS (T_7) followed by Atrazine 1kg *a.i* ha^{-1}+ topramezone SC 33.6% @ 25.2 g. *a.i* ha^{-1} + Atrazine 0.5kg *a.i* ha^{-1} (as early post emergent at 10-12 DAS) (T_5) and atrazine + topramezone 33.6% EC @ 25.2 g. ha^{-1} + dimethanamide 72%EC @600g *a.i* ha^{-1} (as early post emergent 10-12 DAS) (T_4) which was on par with each other and and rest of the treatments are significant.

However at 60, 90 days after sowing and at harvest there was significant difference among the treatments in terms of plant height. At 60, 90 DAS and at harvest significantly higher plant height was recorded with atrazine @ 1kg *a.i* ha^{-1} +intercultural operations and hand weeding at 20 and 40 DAS (T_7) and rest of the treatments are significant. Plant height of maize at 60,90DAS and at maturity was recorded with application of Atrazine @ 1kg *a.i* ha^{-1}+intercultural operations and hand weeding at 20 and 40 DAS (T_7) was significantly higher with other treatments which might be due to reduced weed density and growth which might have favoured the vegetative growth of maize that reflected in plant height. This might be due to weed free situation persisting for nutrition, water, space and light availability throughout crop growth period, created as a result of herbicides application at critical period of crop weed competition that enhanced the crop growth.

Dry matter production

During year of study dry matter accumulation at 30, 60, 90 days after sowing and at harvest there was significant difference among the treatments in terms of dry matter accumulation. At 30,60, 90 DAS and at harvest significantly higher dry matter accumulation was recorded with atrazine @ 1kg *a.i* ha^{-1} +intercultural operations and hand weeding at 20 and 40 DAS (T_7) and rest of the treatments are significant. Significantly increased dry matter accrual in maize under these treatments could be attributed to less weed competition, maximum weed control efficiency, improved nutrient uptake, which might lead to the increased plant height and ultimately might have provided better growth environment to the crop as the weed density and dry matter recorded in these treatments was significantly less enabling the crop to put forth satisfactory growth.

Yield attributes

The results revealed of the experiment the yield attributes viz., Number of Cobs $Plant^{-1}$, cob length, Cob girth, Number of Kernel Rows Cob^{-1}, Total Number of Kernels Cob^{-1} and 100 grain weight of maize was significantly influenced by different weed control treatments.

No variation in the number of cobs $plant^{-1}$ due to different weed control treatments was observed in maize as this character is mostly controlled by the genetic makeup and the treatments imposed had failed to influence significantly.

Application of Atrazine @ 1kg *a.i* ha^{-1}+ intercultural operations and hand weeding at 20 and 40 DAS (T_7) recorded significantly more cob length, Cob girth and Number of Kernel Rows $Cob^{-1}$was statistically on a par with T_5, T_1, T_4 and T_2 treatments and rest of the treatments are significant.

The maximum number of kernels cob^{-1} and 100 grain weight were recorded with application of Atrazine @ 1kg *a.i* ha^{-1}+ intercultural operations and hand weeding at 20 and 40 DAS (T_7). The better performance of these weed control treatments over unweeded control with regard to yield attributes could be ascribed to higher accumulation of drymatter in plant increased nutrient uptake by crop with effective weed control achieved by these treatments might have promoted the efficient translocation of photosynthates from source to sink. These findings are in conformity with findings of Ghodratollah Fathi (2005) [4], Patel *et al.* (2006) [8], Hussein *et al.* (2008) [5], Deshmukh *et al.* (2008) [3], Srividya (2010) [13] and Aleem Ahmed *et al.* (2012) [1].

Grain and Stover Yields

The data indicates that weed management pratices had significant effect in influencing the grain and stover yield of maize. Pre emergence of atrazine 1 kg *a.i* ha^{-1} + intercultural operations and hand weeding at 20 and 40 DAS (T_7) has recorded significantly highest grain and stover yields and rest of the treatments are significant. Significantly highest grain yield recorded in T_7 treatment might be due to application of atrazine 1 kg *a.i* ha^{-1} followed by intercultural operations and hand weeding at 20 and 40 DAS (T_7) which could be attributed to drastic decrease in weed population and dry matter accumulation by weeds, might have reduced crop weed competition. Further, improvement of soil physical condition due to inter cultivation and hand weeding promoted root growth which resulted in adequate nutrient uptake and better crop growth and yield attributes also contributed for higher yields.

The lower yield in weedy check could be attributed to season long crop weed competition, poor weed control as evidenced by higher weed dry weight, which resulted in lower crop dry matter, decreased plant height, which finally resulted in reduced crop growth and lower yield attributing characters. These findings are in accordance with the findings of Pandey *et al.* (2001) [7], Patel *et al.* (2006) [8], Rao *et al.* (2009) [9], Sandhyarani and Karunasagar (2013) [10], Aleem Ahmed *et al.* (2012) [1] and Sonawane *et al.* (2014) [12]

Harvest Index

Higher (45.26%) and lower (39.4%) harvest indices were recorded with Application of Atrazine @ 1kg *a.i* ha^{-1}+

intercultural operations hand weeding at 20 and 40 DAS (T_7) and Unweeded control (T_8), respectively. The increased harvest index might be due to greater translocation of photosynthates as evidenced by higher yields. These results are in conformity with those reported by Nagalakshmi *et al*. (2006) [6], and Srividya (2010) [13].

Table 1: Plant height (cm) as influenced by different weed control treatments in *rabi* maize

Treatments	Plant height (cm)			
	30 DAS	60 DAS	90 DAS	At harvest
T_1 - Topramezone 33.6 EC 25.2 g ha^{-1} + Dimethanamide 72 EC 570 g ha^{-1} (POE)	49.0	159.3	183.7	192.0
T_2 - Topramezone 33.6 EC 25.2 g ha^{-1} + Atrazine 80 WP 0.5 kg ha^{-1} (POE)	43.7	152.7	177.0	186.0
T_3 - Atrazine 50 WP 1.0 kg ha^{-1} fb 2, 4-D 50 WP 0.5 kg ha^{-1} (POE)	44.3	150.0	174.3	183.0
T_4 - Atrazine 50 WP 1.0 kg ha^{-1} fb Topramezone 33.6 EC 25.2 g ha^{-1} +Dimethanamide 72 EC 570 g ha^{-1} (POE)	47.0	155.3	179.3	188.3
T_5 - Atrazine 50 WP 1.0 kg ha^{-1} fb Topramezone 33.6 EC 25.2 g. ha^{-1} + Atrazine 50WP 0.5 kg ha^{-1} (POE)	52.0	157.7	181.3	190.3
T_6 - Atrazine 50 WP 1.0 kg ha^{-1} fb Atrazine 50 WP 1.0 kg ha^{-1} (POE)	47.3	144.3	168.0	175.0
T_7 - Atrazine 50 WP 1.0 kg ha^{-1} fb intercultural operations and hand weeding at 20 and 40 DAS	53.0	180.7	204.0	212.7
T_8 - Unweeded control	36.7	123.3	149.0	154.0
SEm (±)	1.65	5.76	5.27	5.91
CD (0.05)	5.00	17.46	16.00	17.92

Table 2: Dry matter production (kg ha^{-1}) as influenced by different weed control treatments in *rabi* maize

Treatment	Dry matter production (kg ha^{-1})			
	30 DAS	60 DAS	90 DAS	At harvest
T_1 - Topramezone 33.6 EC 25.2 g ha^{-1} + Dimethanamide 72 EC 570 g ha^{-1} (POE)	816	7431	8918	12390
T_2 - Topramezone 33.6 EC 25.2 g ha^{-1} + Atrazine 80 WP 0.5 kg ha^{-1} (POE)	793	7233	8687	12069
T_3 - Atrazine 50 WP 1.0 kg ha^{-1} fb 2, 4-D 50 WP 0.5 kg ha^{-1} (POE)	767	7020	8423	11705
T_4 - Atrazine 50 WP 1.0 kg ha^{-1} fb Topramezone 33.6 EC 25.2 g ha^{-1} + Dimethanamide 72 EC 570 g ha^{-1} (POE)	805	7371	8843	12285
T_5 - Atrazine 50 WP 1.0 kg ha^{-1} fb Topramezone 33.6 EC 25.2 g. ha^{-1} + Atrazine 50WP 0.5 kg ha^{-1} (POE)	850	7738	9285	12901
T_6 - Atrazine 50 WP 1.0 kg ha^{-1} fb Atrazine 50 WP 1.0 kg ha^{-1} (POE)	761	6964	8315	11552
T_7 - Atrazine 50 WP 1.0 kg ha^{-1} fb intercultural operations and hand weeding at 20 and 40 DAS	1051	9588	11505	15982
T_8 - Unweeded control	649	5902	7083	9842
SEm (±)	27.2	250.4	298.2	413.7
CD (0.05)	82.6	759.6	904.6	1254.8

Table 3: Yield attributes as influenced by different weed control treatments in *rabi* maize

Treatments	Cob length (cm)	Cob girth (cm)	No. of rows/cob	Total Number of kernels per cob	100 grain weight (g)
T_1 - Topramezone 33.6 EC 25.2 g ha^{-1} + Dimethanamide 72 EC 570 g ha^{-1} (POE)	20.0	17.0	14.0	282	20.5
T_2 -Topramezone 33.6 EC 25.2 g ha^{-1} + Atrazine 80 WP 0.5 kg ha^{-1} (POE)	19.0	16.3	13.7	270	19.6
T_3 - Atrazine 50 WP 1.0 kg ha^{-1} fb 2, 4-D 50 WP 0.5 kg ha^{-1} (POE)	18.7	16.0	13.3	260	18.9.
T_4 - Atrazine 50 WP 1.0 kg ha^{-1} fb Topramezone 33.6 EC 25.2 g ha^{-1} +Dimethanamide 72 EC 570 g ha^{-1} (POE)	19.3	16.7	14.0	280	21.5
T_5 - Atrazine 50 WP 1.0 kg ha^{-1} fb Topramezone 33.6 EC 25.2 g. ha^{-1} + Atrazine 50WP 0.5 kg ha^{-1} (POE)	21.0	17.0	14.3	298	20.3
T_6 - Atrazine 50 WP 1.0 kg ha^{-1} fb Atrazine 50 WP 1.0 kg ha^{-1} (POE)	18.7	15.7	13.3	254	18.4
T_7 - Atrazine 50 WP 1.0 kg ha^{-1} fb intercultural operations and hand weeding at 20 and 40 DAS	23.7	17.7	14.7	375	24.5
T_8 - Unweeded control	15.7	15.3	12.7	235	15.3
SEm (±)	0.8	0.3	0.4	12.9	0.9
CD (0.05)	2.5	0.9	1.1	39.1	2.8

Table 4: Grain yield, Stover yield and harvest index of *rabi* maize as influenced by different weed control treatments

Treatments	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)
T_1 - Topramezone 33.6 EC 25.2 g ha^{-1} + Dimethanamide 72 EC 570 g ha^{-1} (POE)	5127	6561	43.9
T_2 - Topramezone 33.6 EC 25.2 g ha^{-1} + Atrazine 80 WP 0.5 kg ha^{-1} (POE)	4902	6483	43.1
T_3 - Atrazine 50 WP 1.0 kg ha^{-1} fb 2, 4-D 50 WP 0.5 kg ha^{-1} (POE)	4726	6318	42.8
T_4 - Atrazine 50 WP 1.0 kg ha^{-1} fb Topramezone 33.6 EC 25.2 g ha^{-1} +Dimethanamide 72 EC 570 g ha^{-1} (POE)	5097	6492	43.95
T_5 - Atrazine 50 WP 1.0 kg ha^{-1} fb Topramezone 33.6 EC 25.2 g. ha^{-1} + Atrazine 50WP 0.5 kg ha^{-1} (POE)	5403	6766	44.4
T_6 - Atrazine 50 WP 1.0 kg ha^{-1} fb Atrazine 50 WP 1.0 kg ha^{-1} (POE)	4615	6284	42.3
T_7 - Atrazine 50 WP 1.0 kg ha^{-1} fb intercultural operations and hand weeding at 20 and 40 DAS	6821	8249	45.26
T_8 - Unweeded control	3665	5622	39.4
SEm (±)	187.02	203.33	0.45
CD (0.05)	567.24	616.71	1.38

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