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Impact of Weed Management Practices on Yield Attributes, Economics and Phytotoxicity of *Kharif* Maize

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during 2018 and 2019 at Tamil Nadu Agricultural University, Agriculture College and Research Institute, Coimbatore to study the impact of weed management practices on yield attributes, economics and phytotoxicity of *kharif* maize. Ten treatments were tested in randomized block design with three replications *viz.,* pre emergence (PE) atrazine at 0.5 kg a.i. ha^{-1} *fb* hand weeding (HW) at 20 DAS, PE atrazine at 0.5 kg a.i. ha^{-1} *fb* power weeder (PW) at 20 DAS, PE atrazine at 0.5 kg a.i. ha^{-1} + pendimethalin at 1 kg a.i. ha^{-1} (Tank mix), PE atrazine at 0.5 kg a.i. ha^{-1} + pendimethalin at 1 kg a.i. ha^{-1} *fb* HW at 20 DAS, early post emergence (EPoE) topramezone at 25.2 g a.i. ha^{-1}, PE atrazine at 0.5 kg a.i. ha^{-1} *fb* EPoE topramezone at 25.2 g a.i. ha^{-1}, EPoE tembotrione at 122 g a.i. ha^{-1}, PE atrazine 0.5 kg a.i. ha^{-1} *fb* EPoE tembotrione 122 g a.i. ha^{-1}, hand weeding twice at 20 and 45 DAS and control (weedy check). Among the different weed management practices significantly higher yield attributes *viz*., cob length, cob girth, weight of cob, No. of grain rows cob^{-1}, No. of grains cob^{-1}, grain yield cob^{-1} was found with hand weeding twice at 20 and 45 DAS and it was at par with atrazine at 0.5 kg a.i. ha^{-1} as PE *fb* topramezone at 25.2 g a.i. ha^{-1} as EPoE and atrazine at 0.5 kg a.i. ha^{-1} as PE + tembotrione at 122 g a.i. ha^{-1} as EPoE. Maximum net return and B:C ratio were recorded under atrazine at 0.5 kg a.i. ha^{-1} as PE *fb*

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topramezone at 25.2 g a.i. ha^{-1} as EPoE followed by atrazine at 0.5 kg a.i. ha^{-1} as PE + tembotrione at 122 g a.i. ha^{-1} as EPoE. However, among the different herbicidal treatments used, all the herbicidal treatments were found to be safe to the maize crop without any caused phototoxic effect on maize during both the years of experimentation. Now-a-days, increased labour scarcity and costs are encouraging farmers to adopt labour and cost- saving options by using chemical method.

Keywords: Pre emergence herbicides; early post emergence herbicides; yield attributes; economics and phytotoxic.

1. INTRODUCTION

In the world cereals production, maize ranks third after rice and wheat, but in terms of productivity it surpasses all cereals. Maize is a heavy feeder for both soil moisture and nutrients because of higher production within a short period. In India, total area, production and average productivity of maize are 7.33 m ha, 19.41 m t and 2648 kg ha^{-1} respectively [1]. Compared to world production, in India productivity of maize is low due to various biotic and abiotic factors. Among the biotic constraints, yield loss could be assignable to poor weed management, resulting in huge losses ranging from 28 to 100 per cent [2]. In India, weed infestation is severe in maize crop due to various factors which helps in creating congenial conditions for weed growth. Its cultivation in monsoon season, wider spacing and slow initial crop growth are favouring high weed infestation resulting in greater loss to maize crop production. On an average, the total economic loss in 18 major cultivable crops in India *viz*., (direct-seeded rice, transplanted rice, wheat, maize, sorghum, pearlmillet, greengram, groundnut, soybean, sesame and mustard) is equivalent to USD 11 billion $annum^{-1}$, out of which maize crop alone accounts for economic loss of 25.3 per cent due to weed flora [3]. Thus in order to explore the potential yield of maize, weed control methods are considered to be a prime factor for achieving higher crop production.

Initially manual and mechanical management of weeds though proved effective but, these are often difficult due to scarcity of labour, reduced labour efficiency, difficulty in operating machines during unfavourable conditions and higher expenditure [4]. In such conditions, chemical method of weed control using pre or post-emergence herbicides is an obvious choice during the critical period of crop weed competition [5]. However, the knowledge about the suitable herbicide and application time is necessary to have effective control of targeted weed without any phototoxic injury to the plant. Such knowledge is lacking especially in Indian farmers under field condition resulting into either yield loss due to weed or complete failure of crop due to phototoxic injury of herbicides. Hence, keeping the above facts in view, the present investigation entitled Impact of weed management practices on yield attributes, economics and phytotoxicity of *kharif* maize.

2. MATERIALS AND METHODS

A field experiment entitled was carried out during *kharif* season of 2018 and 2019 at Agriculture College and Research Institute, Tamil Nadu Agricultural University, Coimbatore which is situated at 11°1'6" north latitude and 76°58'21" east longitude with an altitude of 426.7 m above mean sea level (MSL). It comes under agro-climatic region-12 and western zone (Zone-III) of Tamil Nadu. The experiment was laid out in a completely randomized block design with three replications. Before sowing of maize, representative soil samples from 0-15 cm depth were collected randomly from 5 places to determine physico-chemical properties of soil.

The soil of the experimental field during both years was sandy clay loamy in texture containing sand (46.6 and 47.8 %), silt (19.6 and 19.8 %) and clay (33.8 and 32.4 %) with pH (8.46 and 8.25) and electrical conductivity (1.76 and 1.92) during both the years respectively. The treatments consisted of ten weed management practices *viz*., T_1-PE (pre emergence) atrazine at 0.5 kg a.i. ha^{-1} *fb* hand weeding (HW) at 20 DAS, T_2-PE atrazine at 0.5 kg a.i. ha^{-1} *fb* power weeder (PW) at 20 DAS, T_3-PE atrazine at 0.5 kg a.i. ha^{-1} + pendimethalin at 1 kg a.i. ha^{-1} (Tank mix), T_4-PE atrazine at 0.5 kg a.i. ha^{-1} + pendimethalin at 1 kg a.i. ha^{-1} (Tank mix) *fb* HW at 20 DAS, T_5-EPoE (Early post emergence) topramezone at 25.2 g a.i. ha^{-1}, T_6-PE atrazine at 0.5 kg a.i. ha^{-1} *fb* EPoE topramezone at 25.2 g a.i. ha^{-1}, T_7-EPoE tembotrione at 122 g a.i. ha^{-1} and T_8-PE atrazine at 0.5 kg a.i. ha^{-1} *fb* EPoE tembotrione at 122 g a.i. ha^{-1}, T_9- hand weeding twice at 20 and 45 DAS and T_{10}- control.

Maize hybrid CO 6 was manually dibbled at a spacing of 60 cm x 25 cm with seed rate of 20 kg ha^{-1} sown on 11 July and 01 July during 2018 and 2019 respectively. The gross plot size was 4.8 m x 4.5 m and net plot size was 2.4 m x 3.5 m. In maize, half recommended dose of nitrogen and potassium were applied as basal dose along with full dose of P, the remaining nitrogen was applied in two splits dose each at knee high and pre-tasselling stage and potassium was applied in pre-tasselling stage. Pre- emergence and early post-emergence herbicides were applied at within 1 day after sowing and 20 days after sowing using water volume of 500 liters ha^{-1}. Cost of cultivation and gross returns were calculated on the basis of prevailing market prices of different inputs and produces, respectively.

3. RESULTS AND DISCUSSION

3.1 Phytotoxicity Effect on Maize

The phytotoxicity effect of herbicide on maize crop was evaluated based on phytotoxicity scoring chart [6] Table 1 from 3 DAHA (days after herbicide application) to 15 DAHA. From the results it was noticed that toxicity was not observed in all herbicide applied treatments. Results are in accordance with [7] who stated that reduction of weed infestation with application of herbicides can be attributed to the phytotoxic effect of herbicides on weeds and led to inhibition of seed germination and photosynthesis in weeds but not on maize crop.

3.2 Effect on Yield Attributes

Various yield contributing characters *viz*., cob length (20.18 cm and 20.96), cob girth (4.28 cm and 4.56 cm), weight of cob (220.4 g and 221.7 g), No. of grain rows cob^{-1} (14.66 and 14.33), No. of grains cob^{-1} (520 and 528), grain yield cob^{-1} (206.20 g and 207.13 g) and yield recorded under hand weeding twice at 20 and 45 DAS treatment during 2018 and 2019 respectively as well as with pre emergence atrazine at 0.5 kg a.i. ha^{-1} *fb* either early post emergence topramezone at 25.2 g a.i. ha^{-1} at 20 DAS or early post emergence tembotrione at 122 g a.i. ha^{-1} at 20 DAS were significantly higher than other weed control treatment as well as unweeded check during both the years of study Table 2s, 3 and 3a). This might be due to better translocation of photosynthates from source to sink as a result of efficient utilization of growth resources because of weed free conditions.

Unweeded control produced the least number of matured grains cob^{-1} (326 and 318) and yield during *kharif* 2018 and 2019. The decreasing in grain yield cob^{-1} in unweeded control when compared to pre emergence atrazine at 0.5 kg a.i. ha^{-1} *fb* either early post emergence topramezone at 25.2 g a.i. ha^{-1} at 20 DAS was 52.92 per cent and 53.13 per cent, in pre emergence atrazine at 0.5 kg a.i. ha^{-1} *fb* either early post emergence tembotrione at 122 g a.i. ha^{-1} at 20 DAS was 52.12 per cent and 52.56 per cent treatments during *kharif* 2018 and 2019 respectively. This might be due to the presence of weeds during entire crop period which inhibited the cob length, cob girth and weight of cob thus resulted in poor number of grains cob^{-1} under unweeded control treatment. This finding is in conformity with the result of [8] and support to the present investigation of vigorous weed growth leading to reduction in yield attributes.

No significant difference was found among between different weed control treatments with respect to test weight (100 grain weight) and harvest index during both the years of study.

3.3 Effect on Economics

Maximum gross return (132878 ₹ ha^{-1} and 133652 ₹ ha^{-1}) was recorded in treatment hand weeding twice at 20 and 45 DAS in 2018 and 2019 respectively Figs. 1 and 2. Among the different herbicidal treatments pre emergence atrazine at 0.5 kg a.i. ha^{-1} *fb* early post emergence topramezone at 25.2 g a.i. ha^{-1} which was found statistically at par with pre emergence atrazine at 0.5 kg a.i. ha^{-1} *fb* early post emergence tembotrione at 122 g a.i. ha^{-1} recorded maximum gross return. The treatment unweeded control recorded minimum gross return (69294 ₹ ha^{-1} and 67164 ₹ ha^{-1} in 2018 and 2019 respectively) as compared to all other treatments. Significant increase in grain and stover yield due to hand weeding practices and best combination of weed control treatments *i.e.* T_6 and T_8 resulted in significant increase in gross return.

However, the maximum net return and B:C ratio were recorded under pre emergence atrazine at 0.5 kg a.i. ha^{-1} *fb* early post emergence topramezone at 25.2 g a.i. ha^{-1} (75152 ₹ ha^{-1} and 77557 ₹ ha^{-1}) and pre emergence atrazine at 0.5 kg a.i. ha^{-1} *fb* early post emergence tembotrione at 122 g a.i. ha^{-1} (73575 ₹ ha^{-1} and 76497₹ ha^{-1}) due to lower cost of cultivation than

hand weeding twice at 20 and 45 DAS. The higher gross return and lower cost of cultivation in these two treatments contributed for maximum net return. Higher monetary returns due to chemical weed control in maize have been supported by [9] and [10] by using atrazine.

Table 1. Phytotoxicity rating for crops

Effect	Rating	Description
None	0	No injury
Slight	1-3	Slight stunting to Injury more pronounced but not persistent
Moderate	4-6	Moderate injury to Near severe injury
Severe	7-9	Severe injury to Very few plants alive
Complete	10	Complete destruction

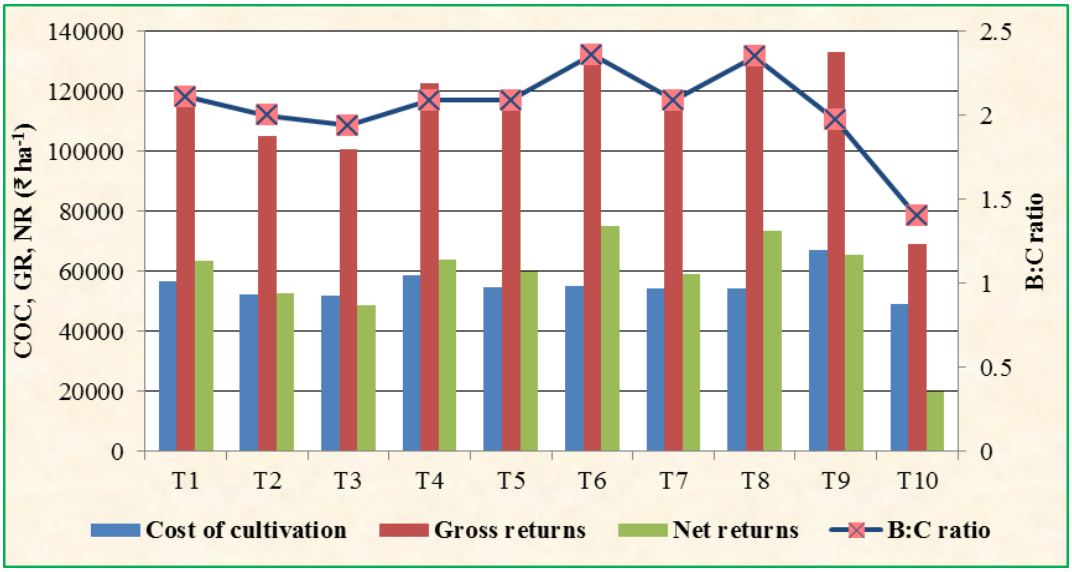

Fig. 1. Effect of weed management practices on economics in maize during *kharif* 2018

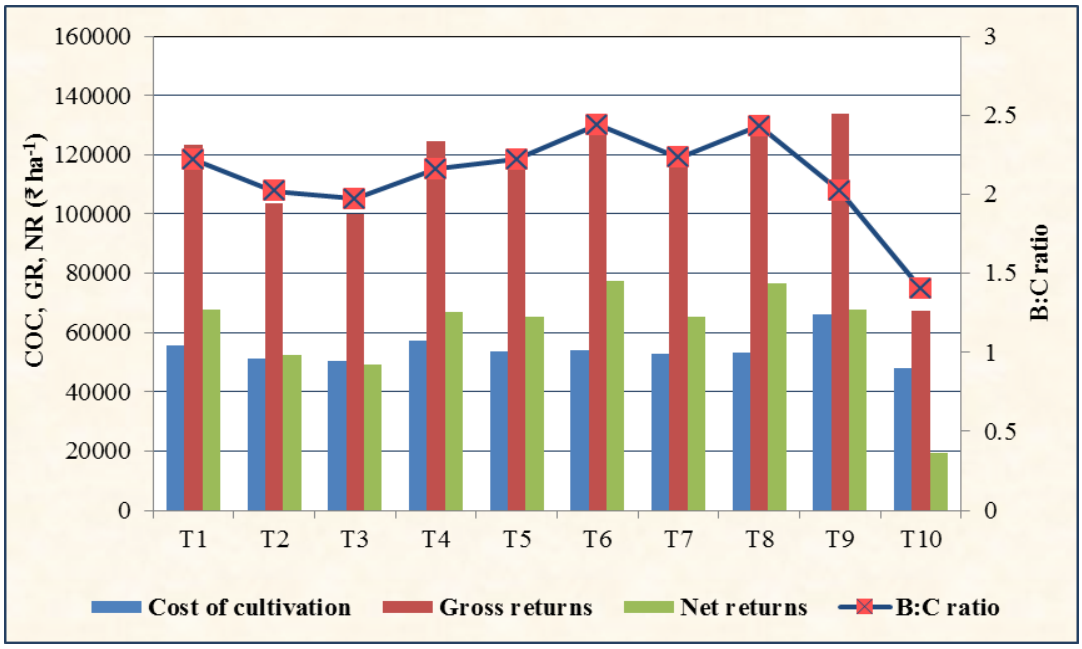

Fig. 2. Effect of weed management practices on economics in maize during *kharif* 2019

Table 2. Effect of Weed Management Practices on Yield Attributes of Maize during *Kharif* 2018 and 2019

Treatments		Cob length (cm)		Cob girth (cm)		Weight of cob (g)		No. of grain rows cob^{-1}	
		2018	2019	2018	2019	2018	2019	2018	2019
T_1:	PE atrazine 50% WP at 0.5 kg a.i. ha^{-1} *fb* HW at 20 DAS	18.75	19.21	3.84	3.88	191.4	190.3	13.00	13.33
T_2:	PE atrazine 50% WP at 0.5 kg a.i. ha^{-1} *fb* PW at 20 DAS	14.15	14.43	3.08	3.18	149.2	163.4	11.66	12.33
T_3:	PE atrazine 50% WP at 0.5 kg a.i. ha^{-1} + pendimethalin 30 % EC at 1 kg a.i. ha^{-} (Tank mix)	13.90	14.21	3.05	3.06	140.8	159.2	11.66	12.00
T_4:	PE atrazine 50% WP at 0.5 kg a.i. ha^{-1} + pendimethalin 30 % EC at 1 kg a.i. ha^{-1} (Tank mix) *fb* HW at 20 DAS	18.69	19.65	3.82	3.92	187.2	194.6	14.00	14.00
T_5:	EPoE topramezone 33.6% SC at 25.2 g a.i. ha^{-1} at 20 DAS	16.53	16.93	3.49	3.48	172.3	175.3	12.66	13.00
T_6:	PE atrazine 50% WP at 0.5 kg a.i. ha^{-1} *fb* EPoE topramezone 33.6% SC at 25.2 g a.i. ha^{-1} at 20 DAS	19.96	20.85	4.31	4.62	214.6	217.3	14.33	14.00
T_7:	EPoE tembotrione 42% SC at 122 g a.i. ha^{-1} at 20 DAS	15.92	17.02	3.38	3.56	162.5	178.4	12.66	13.00
T_8:	PE atrazine 50% WP at 0.5 kg a.i. ha^{-1} *fb* EPoE tembotrione 42% SC at 122 g a.i. ha^{-1} at 20 DAS	19.98	20.78	4.28	4.56	210.1	212.2	14.33	14.00
T_9:	Hand weeding twice at 20 and 45 DAS	20.18	20.96	4.57	4.71	220.4	221.7	14.66	14.33
T_{10}:	Control	11.14	11.62	3.00	3.01	127.5	146.8	11.33	12.00
SEd		0.51	0.41	0.12	0.13	5.26	4.37	0.31	0.21
CD (P=0.05)		1.09	1.05	0.27	0.28	11.52	10.35	0.69	0.53

Table 3. Effect of weed management practices on yield attributes of maize during *kharif* 2018 and 2019

Treatments		No. of grains cob^{-1}		Grain yield cob^{-1} (g)		Test weight (g)	
		2018	2019	2018	2019	2018	2019
T_1:	PE atrazine 50% WP at 0.5 kg a.i. ha^{-1} *fb* HW at 20 DAS	479	489	173.20	177.52	36.51	36.45
T_2:	PE atrazine 50% WP at 0.5 kg a.i. ha^{-1} *fb* PW at 20 DAS	429	430	140.20	134.25	34.96	34.97
T_3:	PE atrazine 50% WP at 0.5 kg a.i. ha^{-1} + pendimethalin 30 % EC at 1 kg a.i. ha^{-1} (Tank mix)	387	434	135.70	129.60	34.32	34.56
T_4:	PE atrazine 50% WP at 0.5 kg a.i. ha^{-1} + pendimethalin 30 % EC at 1 kg a.i. ha^{-1} (Tank mix) *fb* HW at 20 DAS	487	484	179.50	185.60	36.54	36.48
T_5:	EPoE topramezone 33.6% SC at 25.2 g a.i. ha^{-1} at 20 DAS	461	461	161.30	154.30	35.43	36.45
T_6:	PE atrazine 50% WP at 0.5 kg a.i. ha^{-1} *fb* EPoE topramezone 33.6% SC at 25.2 g a.i. ha^{-1} at 20 DAS	517	515	201.40	203.20	38.76	38.54
T_7:	EPoE tembotrione 42% SC at 122 g a.i. ha^{-1} at 20 DAS	452	465	154.60	146.98	35.43	35.49
T_8:	PE atrazine 50% WP at 0.5 kg a.i. ha^{-1} *fb* EPoE tembotrione 42% SC at 122 g a.i. ha^{-1} at 20 DAS	511	520	198.10	199.87	37.82	38.41
T_9:	Hand weeding twice at 20 and 45 DAS	520	528	206.20	207.13	40.02	40.00
T_{10}:	Control	326	318	94.80	95.23	34.27	33.54
SEd		4	6	3.57	3.88	2.45	2.64
CD (P=0.05)		11	15	9.13	9.01	NS	NS

Table 3a. Effect of weed management practices on yield of maize during *kharif* 2018 and 2019

Treatments		Grain yield (kg ha^{-1})		Stover yield (kg ha^{-1})		HI	
		2018	**2019**	**2018**	**2019**	**2018**	**2019**
T_1:	PE atrazine 50% WP at 0.5 kg a.i. ha^{-1} *fb* HW at 20 DAS	7597	7796	12637	12987	0.375	0.375
T_2:	PE atrazine 50% WP at 0.5 kg a.i. ha^{-1} *fb* PW at 20 DAS	6673	6572	9976	10015	0.401	0.396
T_3:	PE atrazine 50% WP at 0.5 kg a.i. ha^{-1} + pendimethalin 30 % EC at 1 kg a.i. ha^{-1} (Tank mix)	6384	6324	9685	9842	0.397	0.391
T_4:	PE atrazine 50% WP at 0.5 kg a.i. ha^{-1} + pendimethalin 30 % EC at 1 kg a.i. ha^{-1} (Tank mix) *fb* HW at 20 DAS	7738	7856	12865	13154	0.376	0.374
T_5:	EPoE topramezone 33.6% SC at 25.2 g a.i. ha^{-1} at 20 DAS	7243	7501	12036	12434	0.376	0.376
T_6:	PE atrazine 50% WP at 0.5 kg a.i. ha^{-1} *fb* EPoE topramezone 33.6% SC at 25.2 g a.i. ha^{-1} at 20 DAS	8198	8276	14432	14502	0.362	0.363
T_7:	EPoE tembotrione 42% SC at 122 g a.i. ha^{-1} at 20 DAS	7162	7482	11874	12104	0.376	0.382
T_8:	PE atrazine 50% WP at 0.5 kg a.i. ha^{-1} *fb* EPoE tembotrione 42% SC at 122 g a.i. ha^{-1} at 20 DAS	8065	8174	14219	14393	0.362	0.362
T_9:	Hand weeding twice at 20 and 45 DAS	8374	8421	14536	14673	0.366	0.365
T_{10}:	Control	4387	4246	6978	6947	0.386	0.379
SEd		146	130	197	167	0.014	0.015
CD (P=0.05)		316	283	425	406	NS	NS

4. CONCLUSION

The present investigation revealed that all the yield attributing traits, yield and economics were significantly influenced by various weed management practices. Results clearly suggested that, sequential application of pre emergence herbicide followed by post emergence herbicide for effective control of weeds and realising higher grain yields and net returns.

5. RECOMMENDATION

The application of atrazine at 0.5 kg a.i. ha^{-1} as PE *fb* either topramezone at 25.2 g a.i. ha^{-1} as EPoE or tembotrione at 122 g a.i. ha^{-1} as EPoE were found to be appropriate weed management practices in irrigated maize in *kharif* maize.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Indiastat; 2019. Available:http://www.indiastat.com. Accessed 04 march 2019.
2. Patel VJ, Upadhyay PN, Patel JB, Meisuriya MI. Effect of herbicide mixtures on weeds in *kharif* maize (*Zea mays* L.) under middle Gujarat conditions. Indian Journal of Weed Science. 2006;38(1-2):54-57.
3. Gharde Y, Singh PK, Dubey RP, Gupta PK. Assessment of yield and economic losses in agriculture due to weeds in India. Crop Protection. 2018;10(7):12-18.
4. Rani BS, Sagar GK. Effect of integrated weed management practices on growth, yield and economics of sweet corn. Agricultural Science Digest. 2013;33 (1):46-52.
5. Singh BK, Sennai S, Prasad CS, Rao SBN, Buragohain J, Angami T, Choudhary BU, Thirugnanavel A. Weeders performance evaluation. Indian Journal of Hill Farming. 2017;30(2):268-274.
6. Rao VS. Principle of weed science. Oxford and IBH publihing CO. Pvt. Ltd. New Delhi. 2000;84.
7. Mahadi MA. Growth, nutrient uptake and yield of maize (*Zea mays* L.) as influenced by weed control and poultry manure. International Journal of Science and Nature. 2014;5(1):94-102.
8. Samant TK, Dhir BC, Mohanty B. Weed growth, yield components, productivity, economics and nutrient uptake of maize (*Zea mays* L.) as influenced by various herbicide applications under rainfed condition. Indian Journal of Weed Science. 2015;2(1):79-83.
9. Porwal MK. Economics of weed control measures in winter maize (*Zea mays* L.). Indian Journal of Agronomy. 2000; 45(2):344-347.
10. Kolage AK, Shinde SH, Bhilare RL. Weed management in *kharif* maize. Journal of Maharashtra Agricultural University. 2004; 29(1):110-111.

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