The Bioefficacy of Pre- and Post-Emergence Herbicides in Winter Maize Zea Mays L.

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Abstract

The purpose of this research was to determine whether or not pre- and post-emergence herbicides were equally successful in suppressing weeds and fostering the development of winter maize (Zea mays L.). The study's objective was to compare the herbicides' bioeficiency in controlling weeds and their effect on crop output. The objective of the study was to evaluate the effectiveness of both pre- and post-emergence herbicides in controlling weeds in winter maize fields. Parameters of crop growth and grain output were analyzed alongside weed density and weed biomass. Herbicide dosage, timing, and weed species information was collected and evaluated. Results showed that both pre- and post-emergence herbicides were effective in suppressing weed growth and encouraging the development of winter maize. These results will help farmers and agronomists make more informed decisions when choosing herbicide treatments for winter maize fields.

Keywords: *Bioefficacy, Pre- and Post-Emergence, Herbicides, Winter Maize.*

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1. Introduction

Corn is now more commonly grown than wheat or rice in many parts of the world. Corn has several uses, including as food, fuel, animal feed, and an industrial staple in the form of corn starch and corn syrup. There are six main types of maize grown commercially: dent corn, flint corn, pod corn, popcorn, flour corn, and sweet corn. Animal feed, corn-based human food usage (such as grinding into cornmeal, pressing into corn oil, fermenting and distilling into alcoholic drinks like bourbon whiskey), and chemical feed stocks are just some of the many reasons why field corn is cultivated. Maize is also used to make ethanol and other biofuels. [1-2]

India produces around 2% of the world's total maize but only occupies the fourth spot in terms of area among maize-growing nations. India will have a record-high maize acreage of 9.86 million hectares in 2018-19. India's maize output has expanded from 1.73 million metric tonnes in 1950–51 to an expected 31.51 million metric tonnes in 2019–20, an increase of over 16 times. During that time span, average productivity went from 547 kgha-1 to 2965 kgha-1, a 5.42-fold increase; yet, the land area rose by just around a factor of 3. Despite the fact that

India's productivity is nearly half that of the globe, its maize output per day is on par with that of several of the world's top producers.[3]

During the monsoon (Kharif) season in India, maize is often cultivated. In India, over 85% of the maize land is devoted to Kharif maize, while the remaining 15% is devoted to Rabi maize. There are various biotic and abiotic stressors that are common in the rainfed conditions where over 70% of Kharif maize acreage is farmed. Kharif maize (2706 kg ha-1) is less productive than rabi maize (4436 kg ha-1) because of its stress-prone ecology. Rabi maize is typically cultivated in a guaranteed environment. The spring maize crop area in the states of Punjab, Haryana, and Western Uttar Pradesh has been expanding rapidly in recent years. Maize is the most rapidly expanding and productive grain crop. Since 2010, maize production in India has increased at a rate more than 50 kilogrammes per hectare per year. [4-5]

Several reasons contribute to India's relatively low maize yields compared to the rest of the world, but inadequate weed control is a key cause of this discrepancy. Weeds diminish the crop's photosynthetic efficiency, dry matter production, and distribution to economically valuable areas, all of which lead to a lower sink capacity and a lower grain yield. Weeds affect maize output by 27-60% in India, depending on the size and longevity of the weed population in the crop. The rising need for food, feed, and fibre in India means that effective weed control measures will remain crucial. [6-7]

2. Literature review

Singh, A and Singh, T. (2020) Chenopodium album, which looked to be particularly aggressive throughout the early growth and developmental phases of the maize crop, was discovered in abundance in the winter corn field. Chenopodium album faced stiff competition with Phalaris minor and Convolvulus arvensis in the experimental field. There was evidence that Chenopodium album and Phalaris minor had a competitive influence on the populations of Convolvulus arvensis, Anagallis arvensis, and Melilotus alba. During the growing season of a broadleaf crop, the weeds are more formidable than grasses. Corn that has closed its canopy reduces the weeds' capacity to compete. Broadleaf weeds, on the other hand, are more resilient to the shading effects of maize and may continue competing for a longer period of time.[8]

Jathure, RS. and Rasker, S.K. (2020) Notwithstanding repeated applications of atrazine, a growing number of reports indicate that weed populations are expanding in areas where maize is grown. For efficient management of grasses, sedges, and broad leaved weeds, he suggested using herbicides with a wide range of weed control. To achieve more comprehensive weed management, it is preferable to use tank mix combinations of two herbicides with separate modes of action, as well as integrated weed management practises. Just one mechanical weeding may reduce pesticide dosage by 15-30% in a maize field with no appreciable effect on grain output under low weed infestation circumstances.[9]

Dwidit, D. and Heckendorn. (2019) In order to effectively manage both monocot and dicot weeds in a maize crop, a mixture of Tembotrione (an HPPD inhibiting herbicide) at 200 g a.i. ha-1 and the safer isoxadifen-ethyl at 200 + Tembotrione 100 g a.i. ha-1 was used. When compared to tembotrione alone, tembotrione combined with safener improved results by 10% after two weeks. The tank mix treatment of the post-emergence herbicides topramezone + atrazine @ 25.2 + 250 g a.i. ha-1 significantly reduced the density of grasses, sedges, and wide leaved weeds in maize fields.[10]

V.R and Gerhards, R (2018) Atrazine, simazine, pendimethalin, and alachlor are some of the pre-emergence and post-emergence herbicides used for weed management. Most of these herbicides have a limited ability to control weeds in maize. One potential herbicide-based strategy for weed management is to make advantage of recently introduced herbicides, some of which have novel mechanisms of action. Their impact on soil microbiology must also be investigated, since soil health is a major focus in modern agriculture. With these considerations in mind, research was conducted to identify efficient and cost-effective herbicides for weed control in maize, and to assess the impact of these herbicides on soil dehydrogenase activity, an indicator of the health of soil bacteria.Weeds thrived, outcompeting agricultural plants for water and nutrients.[11]

K., Trabold and Bonfig-Picard, G. (2017). Weeds cause problems for crop development; post-emergence pesticides might eliminate this issue. Tembotrione is a new post emergent broad spectrum systemic, pigment synthesis inhibitor herbicide that inhibits 4-HPPD enzyme. Previously, there were no post emergence herbicides available on the market, which left farmers with few options for dealing with weeds that emerged after pre-emergent herbicides had already been applied. The soil-active herbicide tembotrione is said to be effective against grass and broadleaf weeds until maize canopy closure.[12]

3. Methodology

The methods and materials used, as well as the ambient, meteorological, and germination conditions, are described in depth.

3.1 Experimental site

The Agronomy Research Farm of Acharya Narendra Deva University of Agriculture & Technology is located at Kumarganj, Ayodhya, Uttar Pradesh. Located near the main gate of the university, the farm is easily accessible from the Ayodhya-Raibareilly road. Ayodhya, the closest district office, is located around 42 kilometers away.

3.2 Meteorological condition

The region has a climate that ranges from subhumid to subtropical due to its average annual rainfall of about 1100 mm. About 85 percent of annual precipitation occurs between June and

September, when the south-west monsoon is at its peak. However, there is a chance of isolated showers here and there during winter.

3.3 Mechanical analysis

In order to do a mechanical investigation of the soil, the "Bouyoucos and Hydrometer method" was applied. Summaries of these findings are shown in Table-3.1. In keeping with the triangle system of soil categorization as recognized by the International Society of Soil Science (ISSS). Soil analysis revealed that the experimental field was composed of silt loam..

Table-3.1: Evaluation of the experimental field using mechanical means

S. No.	Components	Values(%)	Method employed
1.	Sand	27.5%	Hydrometer method(Bouyoucos,1936)
2.	Silt	54.0%	
3.	Clay	18.5%	
4.	Texturalclass	Siltloam	Triangularmethod(Lyon *etal.,* 1952)

3.4 Chemical analysis

The original soil sample was evaluated for available nitrogen, phosphorus, potassium, organic carbon, soil pH, and electrical conductivity (EC) using the procedures outlined against each chemical characteristic of soil in Table-3.2. The soil in the experimental field had a pH of 7.9, a low level of organic carbon (0.32%), a moderate level of potassium (210 kg ha-1), and a low level of both accessible nitrogen (180 kg ha-1) and phosphorus (8.5 kg ha-1).

3.5 Procedure

3.5.1 Serial dilution technique

A conical flask containing 250 mL and 90 mL of sterile water was blocked with cotton, and then 10 grams of air-dried soil was added. A conical flask containing the soil and water was shaken by a mechanical shaker to combine the two. It was inoculated into nine milliliters of sterile water in a cotton-clogged culture tube using one milliliter of suspension from a conical flask. A mechanical shaker was used to agitate the contents of the 10-2 test tube. Using a method very similar to the one described before, the appropriate serial dilution was achieved, and the resulting solution was then homogenized. Next, we diluted the fungal and bacterial samples by a factor of 10-3, then 10-4, then 10-5, and so on.

Reagents

- TTC (triphenyl tetrazolium chloride): 3.0 grams TTC dissolved in 100 milliliters of distilled water, kept in an amber-colored container at 2-8 degrees Celsius.
- AR Grade Methanol
- Dissolve 10 mg of triphenyl formazan (TPF) in 100 ml of distilled water to make the standard triphenyl formazan (100 ug Ml-1).

3.6 Estimation method

One gram of air-dried soil was soaked in 1.0 ml of TTC (3%w/v) solution in a test tube with a screw-on cover. A whole day was spent heating these tubes to a temperature of 280 degrees. These test tubes contained 10 ml of methanol and were shaken vigorously. After letting the mixture remain for 6 hours, the supernatant was skilfully removed. It was discovered that the absorbance of the supernatant was 485 nm. A standard curve (0.50-50 ug ML-1) was generated using TPF. Using a standard curve, we were able to calculate the TPF content in the sample. Dehydrogenase activity was measured and expressed as ug TPF g-1 h =1.

3.7 Statistical analysis

The results of the present study were analyzed statistically utilizing a randomized block design (RBD) method. Standard errors of the means (CD) were used to make treatment comparisons where the T test was statistically significant.

4. Results

Table 4.1 shows the density of sedge weeds in winter maize in response to various weed control approaches applied at various development stages. The density of sedge weeds often reduced between planting and harvest. The results indicated that the Pyroxasulfone 85% PE treatments at 127.5g a.i ha-1, 159.4g a.i ha-1, and 255.0 g a.i ha-1 all had the same effect on sedge density as hand weeding twice at 20 and 40 DAS. The Pyroxasulfone 85% PE @ 255.0 g a.i ha-1 treatment significantly reduced weed densities relative to the other treatments and was comparable to the Pyroxasulfone 85% PE @ 159.4 g a.i ha-1 treatment. Hand weeding twice at 20 and 40 DAS resulted in the lowest sedge weed density at 60 DAS, compared to the use of any of the herbicides tested (Pyroxasulfone 85% PE @ 159.4g a.i ha-1 and Tembotrione 34.4% SC (POE herbicides) @ 120 g a.i ha-1). The Pyroxasulfone 85% PE @ 255.0 g a.i ha-1 treatment significantly reduced sedge weed density compared to the other treatments tested, including Pyroxasulfone 85% PE @ 159.4 g a.i ha-1 and Tembotrione 34.4% SC (POE herbicides) @ 120 g a.i ha-1. Hand weeding twice at 20 and 40 DAS yielded results comparable to the lowest density of sedges at 90 DAS reached with Pyroxasulfone 85% PE at 127.5g a.i ha-1, Pyroxasulfone 85% PE at 159.4g a.i ha-1, and Tembotrione 34.4% SC ().

Table 4.1 displays data on the influence of different weed control techniques on the density of sedge weeds in winter maize at different stages of growth. In general, sedge weed density decreased just before harvest. According to the results, the lowest sedge density was observed under Hand weeding twice at 20 and 40 DAS, which was on par with Pyroxasulfone 85% PE @ 127.5g a.i ha-1,Pyroxasulfone 85% PE @ 159.4g a.i ha-1, and Pyroxasulfone 85% PE @ 255.0 g a.i ha-1. The lowest weed density was seen in the Pyroxasulfone 85% PE @ 255.0 g a.i ha-1 treatment, which was also equivalent to the Pyroxasulfone 85% PE @ 159.4 g a.i ha-1 treatment. The lowest sedge weed density at 60 DAS was achieved by hand weeding twice at 20 and 40 DAS, which was also equal to Pyroxasulfone 85% PE @ 159.4g a.i ha-1 and Tembotrione 34.4% SC (POE herbicides) @ 120 g a.i ha-1. The lowest sedge weed density was achieved with the herbicide treatment of Pyroxasulfone 85% PE @ 255.0 g a.i ha-1, however the herbicide treatments of Pyroxasulfone 85% PE @ 159.4 g a.i ha-1 and Tembotrione 34.4% SC (POE herbicides) @ 120 g a.i ha-1 were similarly effective. Hand weeding twice at 20 and 40 DAS was just as effective as 127.5g a.i. ha-1 Pyroxasulfone 85% PE, 159.4g a.i. ha-1 Pyroxasulfone 85% PE, 255.0 g a.i. ha-1 Pyroxasulfone 85% PE, and Tembotrione 34.4% SC in reducing sedge density to a minimum by 90 DAS.

Table 4.1:Typical weeds seen in a laboratory setting

Scientific name	**Common name**	**Local name**	**Family**	**Lifecycle**
Broad leaved weeds				
*Anagallisarvensis*L.	Scarletpimpernel	Krishnaneel	*Compositae*	Annual
*Chenopodiumalbum*L.	Lambsquarters	Bathua	*Chenopodiaceae*	Annual
*Partheniumhysterophorus*L.	Congressgrass	Gajarghas	*Asteraceae*	Perennial
*Melilotusindica*L.	Indiansweetclover	PiliSenji	*Leguminaceae*	Annual
Sedges				
*Cyperusrotundus*L.	Purplenutsedge	Motha	*Cyperaceae*	Perennial
Grassyweeds				
*Cynodondactylon*L.	Bermudagrass	Doob	*Poaceae*	Perennial

Table 4.2:Broad-leaved weed density per square meter of winter maize as a function of weed control treatments

S. No	Treatments	WeeddensityofBroadleavedweedsm^{-2}				
		30DAS	60DAS	90DAS	120DAS	At Harvest
T_1	Pyroxasulfone85%WG (PEherbicide) @ 102 ga.i.ha^{-1}	9.17 (84.3)	6.79 (46.3)	6.71 (45.2.)	6.33 (40.3)	5.79 (33.7)
T_2	Pyroxasulfone85%WG(PE herbicide) @127.5ga.i.ha^{-1}	7.61 (58.1)	7.33 (53.9)	5.75 (33.3)	5.5 (30.5)	4.57 (21.1)
T_3	Pyroxasulfone85%WG(PE herbicide) @159.4ga.i.ha^{-1}	6.27 (39.56)	5.2 (27.29)	5.03 (25.55)	3.43 (12.01)	2.91 (8.71)
T_4	Pyroxasulfone 85% WG (MarketPE herbicide) @ 127.5 g a.i.$_{ha}$-1	8.5 (72.5)	7.66 (58.9)	7.08 (50.3)	5.0 (25.2)	4.44 (19.9)
T_5	Tembotrione34.4%SC(POE herbicides)@ 120 ga.i.ha^{-1}	8.11 (66.0)	6.10 (37.46)	5.65 (32.17)	5.00 (24.6)	4.53 (16.3)
T_6	Handweedingtwiceat 20and 40 DAS	5.0 (20.3)	4.65 (17.3)	4.0 (13)	4.10 (13)	2.86 (5.6)
T_7	Weedycheck	10.24 (95.0)	9.19 (75.6)	8.47 (63.6)	7.28 (46)	6.67 (39.3)
T_8	Pyroxasulfone85%WG(PE herbicide) @255ga.i.ha^{-1}	5.54 (30.94)	4.61 (21.5)	4.41 (19.9)	2.96 (8.80)	2.8 (8.09)
	SEm±	0.47	0.51	0.61	0.49	0.58
	C.Dat 5%	1.41	1.54	1.88	1.50	1.77

Table 4.3:Density of Sedgesm -2 Weeds in Winter Maize and Its Response to Weed Control Treatments

S. No	Treatments	Weeddensityof Sedgesm^{-2}				
		30DAS	60DAS	90DAS	120DAS	ATHARVEST
T_1	Pyroxasulfone85%WG (PEherbicide) @ 102 ga.i.ha^{-1}	4.81 (18.6)	4.71 (16.1)	4.24 (16.2)	3.96 (12)	3.28 (8.3)
T_2	Pyroxasulfone85%WG(PEherbicide) @ 127.5ga.i. ha^{-1}	3.81 (11.0)	3.72 (9.1)	2.9 (6)	2.57 (4.3)	2.12 (4.0)
T_3	Pyroxasulfone85%WG(PEherbicide) @ 159.4ga.i. ha^{-1}	3.08 (6.66)	2.38 (5.21)	2.23 (3)	2.12 (2.6)	1.82 (3.56)
T_4	Pyroxasulfone85%WG(MarketPEherbicide) @127.5 g a.i.ha^{-1}	4.01 (16.5)	3.37 (10.9)	3.36 (10.6)	3.0 (9.5)	2.90 (8.9)
T_5	Tembotrione34.4%SC(POEherbicides) @ 120 ga.i.ha^{-1}	4.18 (13.6)	3.00 (9.25)	2.53 (6.60)	2.32 (5.63)	1.88 (3.78)
T_6	Handweedingtwiceat 20and 40 DAS	2.8 (5.3)	2.39 (3.6)	2.01 (2.3)	1.9 (2.0)	1.76 (1.6)
T_7	Weedycheck	5.27 (27.3)	5.01 (26.4)	4.62 (17)	4.00 (12.3)	3.5 (9)
T_8	Pyroxasulfone85%WG(PE herbicide) @255ga.i.ha^{-1}	2.35 (5.04)	2.30 (4.8)	1.61 (2.1)	1.51 (1.8)	1.30 (1.2)
	SEm±	0.41	0.23	0.31	0.28	0.21
	C.Dat 5%	1.23	0.71	0.93	0.84	0.63

As can be shown in Table 4.4, weed management treatments significantly reduced the amount of nitrogen, phosphorus, and potassium that weeds were able to absorb at 60 DAS.

Nitrogen uptake was significantly lower with hand weeding at 20 and 40 DAS compared to other treatments such as Pyroxasulfone 85% (PE herbicide) @ 127.5 g a.i ha-1, Temobotrione 34.4% POE @ 120 g a.i ha-1, and Pyroxasulfone 85% PE @ 255.0g a.i ha-1. In order to enhance nitrogen absorption, weeds have to be managed.

Phosphorus uptake was greatest under weedy check, then by manual weeding twice at 20 and 40 DAS, which was comparable to the other treatments but much lower than weedy check.

Table 4.4:Nutrient absorption by weeds as a function of weed management methods used (kgha-1).

S.No	Treatments	Nutrientuptakeby weed(kgha^{-1})		
		Nitrogen	Phosphorus	Potassium
T_1	Pyroxasulfone85%WG (PEherbicide) @ 102 ga.i.ha^{-1}	11.12	1.10	12.70
T_2	Pyroxasulfone85%WG(PEherbicide) @ 127.5ga.i. ha^{-1}	5.97	0.81	8.32
T_3	Pyroxasulfone85%WG(PEherbicide) @ 159.4ga.i. ha^{-1}	8.67	1.03	10.60
T_4	Pyroxasulfone 85% WG (MarketPE herbicide) @ 127.5 g a.i.$_{ha}$-1	10.71	1.18	11.56
T_5	Tembotrione34.4%SC(POEherbicides) @ 120 ga.i.ha^{-1}	8.55	0.98	9.53
T_6	Handweedingtwiceat 20and 40 DAS	5.42	0.70	7.84
T_7	Weedycheck	13.90	1.40	14.83
T_8	Pyroxasulfone85%WG(PE herbicide) @255ga.i.ha^{-1}	5.70	0.76	8.04
	SEm±	1.06	0.16	0.71
	C.Dat 5%	3.24	0.48	2.17

When environmental circumstances are favorable for growing crops, the amount of dry matter produced may be used as a measure of resource productivity. Winter maize dry matter output was significantly impacted by weed management tactics, as shown in Table 4.5, which presents data from 30 DAS, 90 DAS, 120 DAS, and harvest. Dry matter yield was lowest under the weediest conditions.With the exception of the 127.5 g a.i. ha-1 of Pyroxasulfone 85% (PE herbicide) and the 120 g a.i. ha-1 of Tembotrione 34.4% POE, the maximum plant dry matter production was recorded under Hand weeding twice at 20 and 40 DAS. Similar trends were also seen at the harvest stage (at 60, 90, and 120 DAS). Under Pyroxasulfone 85% (PE herbicide), dry matter production peaked at 127.5 g a.i ha-1 at 30 DAS, which was on par with Tembotrione 34.4% POE (120.0 g a.i ha-1) and Pyroxasulfone 85% (PE herbicide) (159.4 g a.i ha-1).The patterns established in earlier stages were carried over into later ones. Weeds reduced yields of dry matter across the board.

Table 4.5:Dry matter production (g plant-1) of winter maize as a function of time and weed control treatments

S.No	Treatments	Nutrientuptakeby weed(kgha^{-1})		
		Nitrogen	Phosphorus	Potassium
T_1	Pyroxasulfone85%WG (PEherbicide) @ 102 ga.i.ha^{-1}	11.12	1.10	12.70
T_2	Pyroxasulfone85%WG(PEherbicide) @ 127.5ga.i. ha^{-1}	5.97	0.81	8.32
T_3	Pyroxasulfone85%WG(PEherbicide) @ 159.4ga.i. ha^{-1}	8.67	1.03	10.60
T_4	Pyroxasulfone 85% WG (MarketPE herbicide) @ 127.5 g a.i.$_{ha}$-1	10.71	1.18	11.56
T_5	Tembotrione34.4%SC(POEherbicides) @ 120 ga.i.ha^{-1}	8.55	0.98	9.53
T_6	Handweedingtwiceat 20and 40 DAS	5.42	0.70	7.84
T_7	Weedycheck	13.90	1.40	14.83
T_8	Pyroxasulfone85%WG(PE herbicide) @255ga.i.ha^{-1}	5.70	0.76	8.04
	SEm±	1.06	0.16	0.71
	C.Dat 5%	3.24	0.48	2.17

The results of different treatments on chemical properties (pH, EC, and organic carbon) are shown in Table 4.6, and it is evident that no noticeable response was detected with respect to the usage of herbicides. Treatment Hand weeding twice at 20 and 40 DAS resulted in the lowest pH, lowest EC, and highest organic carbon content.

After 15 days, the herbicide had no influence on the soil's chemical properties (pH, EC, and OC), possibly due to the buffering capacity of the soil and the hydrolytically stable herbicide.

Table 4.6:Soil pH, Electrical Conductivity (dSm-1), and Organic Carbon (%) Following Weed Control Treatments in Winter Maize Harvest

S. No	Treatments	pH	EC(dSm^{-1})	Organic carbon (%)
T_1	Insecticide: pyroxasulfone 85% WG (PE herbicide) at 102 g a.i. ha-1	8.15	0.23	0.35
T_2	Pyroxasulfone 85% WG @ 127.5 g a.i. ha-1 (PE herbicide)	8.25	0.23	0.34
T_3	Pyroxasulfone85%WG (PEherbicide) @ 159.4ga.i. ha^{-1}	8.16	0.23	0.35
T_4	Pyroxasulfone85%WG (MarketPEherbicide)@127.5g a.i.ha^{-1}	8.20	0.23	0.35
T_5	Tembotrione34.4%SC(POEherbicides) @ 120 ga.i.ha^{-1}	8.23	0.24	0.34
T_6	Handweedingtwiceat 20and 40 DAS	8.10	0.22	0.37
T_7	Weedycheck	8.29	0.23	0.34
T_8	Pyroxasulfone85%WG(PE herbicide) @255ga.i.ha^{-1}	8.25	0.24	0.35
	SEm±	**0.09**	**0.01**	**0.01**
	C.Dat 5%	NS	NS	NS

5. Conclusion

The eight treatments included: no treatment, Pyroxasulfone 85% (PE herbicide) at 102 grammes active ingredient per hectare (ha-1), Pyroxasulfone 85% (Market PE herbicide) at 127.5

grammes active ingredient per hectare (ha-1), Tembotrione 34.4% POE at 120 grammes active ingredient per hectare (ha-1), and hand weeding. The research was carried out three times to ensure accuracy using a Randomized Block Design. The most prevalent broad-leaved weeds in the winter maize experimental field were Anagallis arvensis and Chenopodium album, while the most common sedge plant was Cyperus rotundus.

6. References

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