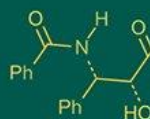


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(8): 1934-1939
www.biochemjournal.com
Received: 26-06-2026
Accepted: 29-07-2026

Madavi SR
Post Graduate Student,
Department of Agronomy,
Swamy Vivekanand University
(SVN), Sagar, Madhya
Pradesh, India

Dongarwar LN
Agriculture Assistant,
Agriculture Research Station,
Dr. Panjabro Deshmukh
Krishi University Akola,
Maharashtra, India

Borkar VH
Agriculture Assistant,
Agriculture Research Station,
Dr. Panjabro Deshmukh
Krishi University Akola,
Maharashtra, India)

Kondawar MR
M.Sc., Plant Physiology, Dr.
Panjabro Deshmukh Krishi
University Akola,
Maharashtra, India

Corresponding Author:
Madavi SR
Post Graduate Student,
Department of Agronomy,
Swamy Vivekanand University
(SVN), Sagar, Madhya
Pradesh, India

Weed management in rainfed maize (*Zea mays* L.) through early post emergent herbicides

Madavi SR, Dongarwar LN, Borkar VH and Kondawar MR

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i8Su.9697>

Abstract

A research trial for M.Sc. student on "Weed management in rainfed maize (*Zea mays* L.) through early post emergent herbicides" was carried on during *kharif* (rainy) at Department of Agronomy, S. V. U. Sagar Madhya Pradesh during *kharif* 2022. In this experiment consisted of 8 treatments. T₁, T₂, T₃, T₄, T₅, T₆, T₇, T₈. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. In this experiment observed at growth parameters: Plant height (cm), Leaf area per plant (cm²), Leaf area index (LAI), Leaf area duration (days), SPAD meter reading (Chlorophyll content), Total dry matter production (g plant⁻¹) and yield characters components: Grain weight per cob (g), Hundred seed weight (g), Grain yield (kg ha⁻¹). At all the growth stages, significantly higher plant height was recorded with T₄. Compared to grain yield per ha was significantly higher (6791 kg/ha) with the T₄ and with T₅ (6609 kg/ha) compared to their single applications.

Keywords: Post emergent, herbicides, rainfed, maize, weed management

Introduction

In 2050, the world will undergo significant changes. The number of people on the planet will rise to over 9 billion, and the average global temperature will increase. Food, fuel, and other basic resources will run out. (Shenggen Fan and Brzeska, 2010, Anon., 2022) [14, 1].

Furthermore, India is a densely populated country, and its population continues to grow at a rapid rate. If the current population growth trend persists, the country may require approximately 301 million tonnes of food grains by 2050 AD, as estimated by the National Academy of Agricultural Sciences. (Shankaran *et al.*, 2005) [11].

In India, maize is cultivated over an area of approximately 8.78 million hectares (M ha), with a total production of 21.76 million tonnes (M t). The average productivity of maize in India is about 2,478 kg ha⁻¹, which is considerably lower than the world average productivity of 4,860 kg ha⁻¹ (Anon., 2022) [1]. Maize plays a significant role in the Indian economy as it is an important source of food and animal feed and also serves as a valuable raw material for various industries.

In recent years, corn oil has gained popularity among consumers because of its cholesterol-free nature. In addition, maize-derived products such as cornstarch, corn flakes, gluten, germ cake, lactic acid, alcohol, and acetone are either consumed directly as food products or utilized as raw materials in various industries, including the paper, textile, and fermentation industries. Approximately two-thirds of the total global maize production is utilized as livestock feed or for the commercial production of starch and oil (Khalil and Jan, 2004) [6].

Maize production and productivity are adversely affected by weed competition, particularly during the vegetative and early reproductive stages of crop growth. Weeds compete with maize plants for essential growth resources, including nutrients, moisture, sunlight, and space, thereby reducing crop growth and yield. Therefore, effective and timely weed management is essential for achieving higher maize productivity. The use of early post-emergence herbicides may provide a viable and effective alternative to conventional weed management practices.

Early post-emergence application of herbicides may involve the use of either a single herbicide or a combination of two herbicides. A well-planned early post-emergence application using a tank mixture of compatible herbicides can provide more effective and broad-spectrum weed control than the application of a single post-emergence herbicide.

Such herbicide combinations can effectively control both broad-leaved weeds and grassy weeds, thereby reducing weed competition during the critical growth stages of the crop.

However, adequate information regarding the efficacy, compatibility, suitable combinations, application rates, and optimal timing of such herbicide mixtures is currently limited. Therefore, there is a need to evaluate suitable early post-emergence herbicide combinations for achieving effective and broad-spectrum weed management.

Materials and Methods

The trial conducted for M.Sc. student at the Department of Agronomy, S. V. U. Sagar Madhya Pradesh during kharif (rainy season) 2022 to study the "Weed management in rainfed maize (*Zea mays* L.) through early post emergent herbicides". The experiment was conducted in the spacing 60 x 20 cm, sowing season *Kharif*, 2022, fertilizer: 100:50:25 N:PO:K₂O kg ha⁻¹, plot size(gross) 4.5 m x 4.2 m and plot size(Net) 3.6 m x 3.2 m, Variety 900-M Gold Seed rate 25 kg ha⁻¹. Treatment are eight and different combination in the table.

Treatment
T ₁ -Topramezone (25 g/ha) at 20 Days After Sowing (Early post-emergence)
T ₂ -Atrazine (1.25 kg/ha) at 20 Days After Sowing (Early post-emergence)
T ₃ -2 4-D Na salt (1 kg/ha) at 20 Days After Sowing (Early post-emergence)
T ₄ -Topramezone (12.5 g/ha) + Atrazine (625g/ha) at 20 Days After Sowing (Early post-emergence) (Tank mixture)
T ₅ -Topramezone (12.5 g/ha) + 2 4-D Na salt (500g/ha) at 20 Days After Sowing (Early post-emergence) (Tank mixture)
T ₆ -Atrazine (PRE) 1.25 kg/ha + IC + Hand Weeding)
T ₇ -Weed free
T ₈ -Weedy check

Observation taken to be selected randomly five plants from sampling area than taken following observations on different growth stages up to harvest.

Plant height (cm)

Plant height was measured from base of the plant to the leaf length was measured from the stage of complete leaf opening until cob emergence, and again from tasselling to the base of the collar of the flag leaf. The measurements were recorded in s cm

Leaf area per plant (dm²)

The leaf area per plant is calculated using the length × breadth method with a correction (multiplication) factor of 0.75 by (Sticker *et al.*, 1961).

$$\text{Leaf Area per Plant (dm}^2\text{)} = \frac{L \times B \times N \times 0.75}{100}$$

Where:

- L = Maximum leaf length (cm)
- B = Maximum leaf breadth (cm)
- N = Total number of green leaves per plant
- 0.75 = Leaf area correction factor
- 100 = Conversion from cm² to dm² (1 dm² = 100 cm²)

Leaf area index (LAI)

Represents the cumulative persistence of leaf area over a specific growth period. It is calculated by integrating the Leaf Area Index (LAI) over time, as originally described by Watson (1952) [20].

$$\text{LAI} = \frac{\text{Leaf area per plant (dm}^2\text{)}}{\text{Land area occupied by the plant (dm}^2\text{)}}$$

Leaf area duration (days)

Leaf area duration days (LAD) are calculated as per formula given by (Watson, 1952) [20] and Power *et al.* (1967) [10].

$$\text{LAD} = \frac{L_1 + L_2}{2} \times T_2 - T_1$$

Where,

LAD = Leaf area duration in days L.

L₂ = LAI at stages 1 and 2

t₂-t₁ = Time interval in days between stages 1 and 2.

SPAD meter reading (Chlorophyll content)

This observation taken from leaf chlorophyll content given by the processor (Clements, 1964) [2].

Total dry matter production (g plant⁻¹)

This plant cut into the ground surface, dried at 70°C and cut into small pieces, Total dry matter produced are calculated in different levels 30, 60, 90 and at harvest.

Yield components and yield

Yield attribute characters observed are as below.

Grain weight per cob (g)

Seeds from five randomly selected, sun-dried cobs were manually separated and weighed. The average seed weight per cob was calculated and recorded as the grain weight per cob (g).

Hundred seed weight (g)

A random sample of 100 seeds was collected from the net plot yield of each treatment. The seeds were weighed using a precision balance, and the weight was recorded in grams (g).

Grain yield (kg ha)

At physiological maturity, cobs were harvested from each treatment separately and dehusked. The harvested cobs were air-dried before shelling, and the grains obtained were thoroughly cleaned and weighed. The grain yield for each treatment was calculated and expressed in quintals per hectare (q ha⁻¹).

Statistical analysis of data

In this experiment the collected data analyzed by statistically described by Gomez and Gomez (1984). The level of significance used in 'F' test was P = 0.05 Critical difference values were calculated wherever the 'F' test was significant.

Results and Discussion

Plant height

The statistically analyzed results are presented in Table 1. Plant height in maize was significantly affected by the weed management treatments at different stages of crop growth. However, at 30 days after sowing (DAS), the treatments did not cause any significant variation in plant height.

At 60 DAS, the weed-free treatment recorded the maximum plant height (175.53 cm). However, it remained statistically at par with treatments T₄ (174.55 cm), T₆ (174.49 cm), T₅ (168.00 cm), T₁ (166.87 cm), T₃ (164.72 cm), and T₂ (164.60 cm). In contrast, treatment T₈ produced the minimum plant height (150.07 cm), which was significantly lower than the other treatments.

At 90 DAS, plant height was significantly influenced by the weed management treatments. The recommended practice (T₆) recorded a plant height of 193.05 cm, followed by T₄ (192.00 cm), T₅ (189.26 cm), and T₂ (175.53 cm). These treatments were statistically at par with T₇, which produced the maximum plant height of 197.97 cm.

At harvest, the T₇ (check) treatment produced the tallest maize plants, recording a plant height of 204.63 cm, which was significantly higher than most other treatments. However, it remained statistically at par with T₄ (199.40 cm), T₆ (196.75 cm), and T₅ (191.60 cm).

These results are in conformity with the findings of Srividya *et al.* (2011) [17]. Significantly lower plant height was observed in T₈ check (169.30 cm). Shinde *et al.* (2001) [15], Likewise, Shekhawat and Gautham (2002) [13] recorded the higher values for all the growth parameters in weed free control, followed by hand weeding twice.

Table 1: Plant height of maize (cm) as influenced by weed management treatments in maize.

Treatment	30 DAS	60 DAS	90 DAS	At harvest
T ₁	36.18	166.87	170.53	177.03
T ₂	39.19	164.60	175.53	184.26
T ₃	38.68	164.72	171.68	182.27
T ₄	42.62	174.55	192.00	199.40
T ₅	37.11	168.00	189.26	191.60
T ₆	45.11	174.49	193.05	196.75
T ₇	46.30	175.53	197.97	204.63
T ₈	35.64	150.07	157.13	169.30
Sem + _	4.23	3.93	8.61	5.428
C.D.(0.5)	12.84	11.91	26.12	16.464

Leaf area

Leaf area of maize, measured in dm² at different growth stages up to harvest, showed significant variation among the weed management treatments (Table 2). However, at 30 DAS, the treatments did not have a significant effect on leaf area.

At 60 DAS, the weed management treatments had a significant effect on the leaf area of maize. The highest leaf area was recorded in T₇ (77.72 dm²), which was statistically at par with T₆ (73.28 dm²) and T₄ (73.11 dm²). The lowest leaf area was observed in the weedy check (T₈), with 49.07 dm². Treatments involving individual herbicide applications, namely T₁ (60.67 dm²), T₂ (55.81 dm²), and T₃ (59.31 dm²), produced significantly lower leaf area compared with the tank mixture treatments.

At 90 DAS, leaf area was significantly influenced by different weed management treatments. The highest leaf

area was recorded in T₄ (77.27 dm²), which was statistically at par with the recommended weed management treatment T₆ (81.14 dm²). Treatment T₅ (73.06 dm²) also showed a leaf area comparable to T₄. In contrast, herbicide treatments T₂ (71.45 dm²), T₁ (70.03 dm²), and T₃ (67.43 dm²) produced significantly lower leaf area values. The lowest leaf area was observed under T₈ (58.63 dm²), indicating its inferior performance compared to the other treatments.

A trend similar to that of 90 DAS was observed at harvest. This is in conformity with the findings of Shantveerayya *et al.* (2012) [12], Ishrat *et al.* (2012) [5] and Nadiger *et al.* (2011) [9]. The TDMP of maize is dependent on growth attributes such as leaf area (LA).

Table 2: Leaf area (dm²) at different growth stages of maize as influenced by weed management treatments in maize.

Treatment	30 DAS	60 DAS	90 DAS	At harvest
T ₁	18.50	60.77	70.03	33.09
T ₂	19.52	55.81	71.45	35.14
T ₃	17.57	59.31	67.43	31.27
T ₄	23.48	73.11	77.27	39.89
T ₅	21.82	67.22	73.06	35.57
T ₆	23.91	73.28	81.14	37.29
T ₇	25.93	77.72	85.14	45.89
T ₈	13.07	49.07	58.63	27.04
Sem + _	2.19	1.59	1.54	1.69
C.D.(0.5)	7.21	4.82	4.658	5.12

Leaf area duration (days)

Leaf area duration computed at (Table 3)

Leaf Area Duration (LAD) exhibited a pattern similar to leaf area and Leaf Area Index (LAI) throughout all growth stages of maize. The accumulation of total dry matter production (TDMP) was closely associated with growth parameters such as plant height and LAD. In addition, LAI is an important growth indicator that reflects the plant's capacity for photosynthesis, transpiration, and biomass accumulation.

It is a major factor determining the solar radiation interception, canopy photosynthesis and therefore yield of maize (Duncon, 1975) [3].

Table 3: Leaf area index of maize as influenced by weed management treatments in maize.

Treatment	30 DAS	60 DAS	90 DAS	At harvest
T ₁	1.54	5.06	5.84	2.76
T ₂	1.63	4.65	5.95	2.93
T ₃	1.46	4.94	5.62	2.61
T ₄	1.96	6.09	6.44	3.32
T ₅	1.82	5.60	6.09	2.96
T ₆	1.99	6.11	6.76	3.11
T ₇	2.16	6.48	7.10	3.82
T ₈	1.09	4.09	4.89	2.25
Sem + _	0.18	0.25	0.32	0.20
C.D.(0.5)	0.55	0.78	0.99	0.61

SPAD meter reading (Chlorophyll content)

Chlorophyll levels measured at 30, 60, 90 days after sowing (DAS), and at harvest showed major differences across the various weed control methods (Table 4).

At 30 DAS, the chlorophyll content of maize was significantly influenced by different weed management treatments. The highest chlorophyll content was recorded in

T₇ (49.70), followed by the recommended treatment T₄ (47.47). Treatments T₆ (46.81), T₂ (45.35), T₅ (44.15), and T₃ (42.55) also produced relatively higher chlorophyll content; however, these treatments were statistically at par with one another. The lowest chlorophyll content was observed in T₈ (37.35), which was significantly inferior to the other treatments.

At 60 DAS, the chlorophyll content of maize varied significantly among the weed management treatments. The highest chlorophyll content was observed in T₇ (43.93), which remained statistically at par with T₄ (42.23), T₅ (Topramezone 12.5 g ha⁻¹ + 2,4-D 500 g ha⁻¹; 42.03), and the recommended practice T₆ (41.90). However, the single-herbicide treatments T₁ (37.70), T₂ (37.37), and T₃ (36.23) recorded significantly lower chlorophyll content than the weed-free check. The lowest chlorophyll content was noted in T₈ (32.07).

At 90 DAS, chlorophyll content was significantly affected by the different weed management treatments. The tank-mix herbicide treatments, T₄ (33.6) and T₅ (30.3), recorded higher chlorophyll content and remained statistically comparable with the recommended weed management practices, T₆ (29.5) and T₇ (33.8). In comparison, the treatments involving application of individual herbicides, T₂ (25.1) and T₃ (26.5), resulted in significantly lower chlorophyll content. The untreated control (T₈) recorded the minimum chlorophyll content (24.5), which was significantly lower than that observed under all other weed management treatments. A similar trend as that of 90 DAS was observed at harvest also. Similar report was made by Madhavi *et al.* (2014) [7].

Table 4: Chlorophyll content (SPAD reading) at 30 DAS, 60 DAS, 90 DAS and at harvest as influenced by weed management treatments in maize.

Treatment	30 DAS	60 DAS	90 DAS	At harvest
T ₁	40.39	37.70	30.3	22
T ₂	45.35	37.37	25.1	19.9
T ₃	42.55	36.23	26.5	16.9
T ₄	47.47	42.23	33.6	23.6
T ₅	44.15	42.03	30.3	20.9
T ₆	46.81	41.90	29.5	23.0
T ₇	49.70	43.93	33.8	22.3
T ₈	37.35	32.07	24.5	12.1
Sem + _	2.38	1.59	1.54	1.69
C.D.(0.5)	7.21	4.82	4.66	5.12

Total dry matter production of maize (g plant⁻¹)

Total dry matter production (TDMP) of maize differed significantly due to weed management treatments (Table 5). At 30 DAS, dry matter accumulation in maize varied significantly among the weed management treatments. The highest dry matter accumulation was recorded in treatment T₇ (12.30 g plant⁻¹), which was statistically at par with T₄ and T₆, both registering 10.26 g plant⁻¹. Treatments T₂ (8.89 g plant⁻¹) and T₅ (8.87 g plant⁻¹) also showed significantly higher dry matter accumulation and remained comparable with the recommended practice. The lowest dry matter accumulation was observed in T₈ (7.58 g plant⁻¹).

At 60 DAS, the highest dry matter accumulation was observed in T₇ (97.94 g plant⁻¹), which was statistically comparable with T₆ (94.43 g plant⁻¹), T₄ (91.50 g plant⁻¹), T₅ (86.31 g plant⁻¹), T₁ (84.34 g plant⁻¹), and T₂ (84.26 g plant⁻¹). However, T₈ produced the lowest dry matter

accumulation (71.48 g plant⁻¹), which was significantly inferior to the other treatments

At 90 DAS, dry matter accumulation in maize was significantly influenced by the different weed management treatments. The recommended weed management practices, T₆ (254.90 g plant⁻¹) and T₄ (250.15 g plant⁻¹), produced significantly higher dry matter accumulation and were statistically at par with T₇ (277.05 g plant⁻¹). These treatments were followed by T₅ (236.86 g plant⁻¹). The treatments involving the individual application of herbicides (T₁, T₂, and T₃) showed dry matter production comparable to that of the herbicide mixture treatments. The lowest dry matter accumulation was observed under T₈ (188.61 g plant⁻¹), which differed significantly from the other treatments

At harvest, dry matter accumulation in maize varied significantly among the weed management treatments. The early post-emergence herbicide treatment T₄ recorded a dry matter production of 296.93 g plant⁻¹, while the recommended weed management practice T₆ produced 294.77 g plant⁻¹. Both treatments were statistically at par with the weed-free treatment T₇, which registered the highest dry matter accumulation (323.64 g plant⁻¹). Treatment T₅ also showed significantly greater dry matter production (267.01 g plant⁻¹) compared to the other herbicide treatments. In contrast, the weedy check (T₈) recorded the lowest dry matter accumulation (190.26 g plant⁻¹). Replaced weed density in the formula given by Mani *et al.* (1973) [8] by weed dry weight to calculate total dry matter production.

Table 5: Total dry matter production (g/plant) at different growth stages of maize as influenced by weed management treatments in maize.

Treatment	30 DAS	60 DAS	90 DAS	At harvest
T ₁	8.7	84.34	215.67	242.99
T ₂	8.89	84.26	224.04	257.22
T ₃	8.22	83.59	220.04	256.78
T ₄	10.26	91.50	250.15	296.93
T ₅	8.87	86.31	236.86	267.01
T ₆	10.26	94.43	254.90	294.77
T ₇	12.30	97.94	277.05	323.64
T ₈	7.58	71.48	188.61	190.26
Sem + _	1.03	4.66	12.16	15.87
C.D.(0.5)	3.13	14.13	36.88	48.14

Yield and Yield Components of Maize

The observations on grain weight per plant, hundred grain weight, gram yield are presented in Table 6.

Grain Weight (g plant⁻¹)

Grain weight per plant was significantly influenced by the different weed management treatments (Table 6). Among the treatments, T₇ recorded the highest grain weight per plant (164.14 g plant⁻¹), which was significantly superior to most other treatments. However, its performance was statistically comparable with T₆ (recommended weed management practice, 145.16 g plant⁻¹) and T₄ (144.43 g plant⁻¹), as these treatments remained at par with each other. The lowest grain weight per plant was recorded under T₈ (80.06 g plant⁻¹), which was significantly inferior to all other treatments. this result is in conformity with the findings of Walia *et al.* (2007) [19].

Table 6: Grain yield (kg ha⁻¹), Hundred grain weight (g), Grain weight (g plant⁻¹) of maize as influenced by weed management treatments in maize.

Treatment	Grain weight (g plant ⁻¹)	100 seed weight (g)	Grain yield (kg ha ⁻¹)
T ₁	117.21	24.58	5707
T ₂	118.12	25.82	5713
T ₃	116.55	23.45	5604
T ₄	144.43	29.38	6791
T ₅	127.82	28.2	6609
T ₆	145.16	30.26	6882
T ₇	164.14	33.19	7103
T ₈	80.06	19.12	4973
Sem ±	7.6	2.14	278
C.D.(0.5)	23.04	6.49	842

Hundred Grain Weight (g)

Hundred-grain weight varied significantly among the different weed management treatments (Table 6). The highest hundred-grain weight was recorded under treatment T₄, while treatments T₅ (28.20 g), T₂, and T₇ (33.19 g) produced statistically comparable values. In contrast, treatment T₆ recorded a significantly lower hundred-grain weight (25.82 g), followed by T₁ (24.58 g) and T₃ (23.45 g). The lowest hundred-grain weight was observed in T₈ (19.12 g), indicating inferior performance compared to the tank-mix herbicide treatments. These results are in conformity with the findings of Walia *et al.* (2007) [19].

Grain Yield of Maize (kg ha⁻¹)

Grain yield of maize was significantly affected by the weed management treatments employed (Table 6). Among the treatments, T₇ produced the highest grain yield (7103 kg ha⁻¹), which was statistically comparable with T₆ (6882 kg ha⁻¹), T₄ (6791 kg ha⁻¹), and T₅ (6609 kg ha⁻¹). These treatments resulted in significantly greater grain yield than T₁ (topramezone alone), T₂ (atrazine alone), and T₃ (2,4-D alone). The lowest grain yield was observed under T₈ (4973 kg ha⁻¹), which was significantly inferior to all other weed management treatments. These results are in conformity with the findings of Srividya *et al.* (2011) [17].

Conclusion

At both 30 and 60 DAS, the tank mixture treatments (T₄ and T₅) significantly reduced the population of broad-leaved weeds, grassy weeds, sedges, and the overall weed dry matter accumulation. Their performance was statistically comparable to the recommended weed management practice. In contrast, the weedy check treatment exhibited the highest weed density and dry weight.

The herbicide tank mixture treatment T₄ resulted in effective weed suppression and recorded a low weed index (4.38%), which was statistically comparable to the recommended weed management practice. Similarly, the pre-emergence herbicide treatments T₆ (3.19%) and T₅ (7.05%) also maintained a low weed index, indicating effective weed control.

At both observation stages (30 and 60 DAS), the tank mixture treatment T₄ exhibited the highest weed control index (WCI), recording 75.99% at 30 DAS and 86.11% at 60 DAS. These values were statistically comparable with T₅ (70.11% and 79.24% at 30 and 60 DAS, respectively) as well as the recommended weed management practice T₆ (77.69% and 88.36% at 30 and 60 DAS, respectively).

At all crop growth stages, the application of tank mixture T₄ resulted in the greatest plant height and was significantly superior to the other weed management treatments. Treatment T₅ produced the second-highest plant height and remained statistically at par with T₄. In contrast, T₈ consistently recorded the lowest plant height throughout all stages of crop growth.

Grain weight per plant was significantly influenced by different weed management treatments. The recommended weed management practice (T₆) produced the highest grain weight per plant (145.16 g plant⁻¹), followed closely by treatment T₄ (144.43 g plant⁻¹). Both treatments were statistically at par with the weed-free treatment. In contrast, the lowest grain weight per plant (80.06 g plant⁻¹) was recorded under treatment T₈.

Grain yield was significantly influenced by the weed management treatments. The tank mixtures T₄ (6791 kg ha⁻¹) and T₅ (6609 kg ha⁻¹) produced significantly higher grain yields than their respective single-herbicide applications. However, the yields obtained with T₄ and T₅ were statistically comparable with the recommended weed management practice T₆ (6882 kg ha⁻¹) and T₇ (7103 kg ha⁻¹). In contrast, T₈ recorded the lowest grain yield of 4973 kg ha⁻¹.

Acknowledgments

I sincerely express my gratitude to the Head, Department of Agronomy, SVU, Sagar (M.P.), for providing the necessary facilities and support to conduct the experiment during Kharif 2022 at the experimental field. I am also thankful to all the staff members of the Agricultural Research Station under Dr. PDKV, Akola, for their valuable assistance and cooperation. I extend my heartfelt thanks to my friends for their help in recording observations, data analysis, and laboratory work, which contributed greatly to the successful completion of this experiment.

Abbreviation

IC: Inter cultivation, HW: Hand Weeding, DAS: Days after sowing, PRE: Pre-emergence herbicide,

References

1. Anonymous. Directorate of Maize Research, Indian Council of Agricultural Research. Vision 2050. 2013. p. 38.
2. Clements HF. Interaction of factors affecting yield. Annual Review of Plant Physiology. 1964;15:409-422.
3. Duncan WG. Maize. In: Evans LT, editor. Crop Physiology. London: Cambridge University Press; 1975. p. 145-147.
4. Gomez KA, Gomez AA. Statistical procedures for agricultural research. 2nd ed. New York, USA: Wiley International Science Publication; 1984.
5. Ishrat DH, Hunshal CS, Malligwad L, Chimmad VP. Effect of pre and post emergence herbicides on weed control in maize. Karnataka Journal of Agricultural Sciences. 2012;25(3):392-394.
6. Khalil IA, Jan A. Cereal crops cropping technology. Islamabad: National Book Foundation; 2004. p. 169-201.
7. Madhavi M, Ramprakash T, Srinivas A, Yakadri M. Topramezone (33.6% SC) + Atrazine (50% WP) tank mix efficacy on maize. In: Biennial Conference of the Indian Society of Weed Science; 2014. p. 23-24.

8. Mani VS, Pandita ML, Gautam KC, Bhagwandas. Weed killing chemicals in potato cultivation. Indian Farming. 1973;23:7-13.
9. Nadiger S. Bioefficacy of pre emergence herbicide on weed management in maize (*Zea mays* L.) [MSc Agriculture thesis]. Dharwad, Karnataka, India: University of Agricultural Sciences; 2011.
10. Power JF, Willis WO, Grumes DL, Reichmann GA. Effect of soil temperature, phosphorus and plant age growth analysis in barley. Agronomy Journal. 1967;59:231-234.
11. Shankaran N, Meena S, Sakthivel N. Input management in maize. Madras Agricultural Journal. 2005;92(7-9):464-468.
12. Shantveerayya H, Agasimani CA, Halikatti SI, Ramesh Babu, Patil CR, Ningnur BT. Effect of herbicides weed control and productivity of maize (*Zea mays* L.). Karnataka Journal of Agricultural Sciences. 2012;25(1):137-139.
13. Shekhawat PS, Gautam RC. Effect of row spacing and weed control methods on the growth attributes and grain yield of maize under tilled and untilled conditions. Annals of Agricultural Research. 2002;23(4):626-629.
14. Fan S, Brzeska J. The role of emerging countries in global food security. IFPRI Policy Brief. Washington, DC: International Food Policy Research Institute; 2010. p. 15.
15. Shinde SH, Kolage AK, Bhilare RL. Effect of weed control on growth and yield of maize. Journal of Maharashtra Agricultural University. 2001;26(2):212-213.
16. Sreenivas G, Satyanarayana V. Nutrient removal by weeds and maize (*Zea mays*). Indian Journal of Agronomy. 1994;41(1):160-162.
17. Srividya S, Chandrasekhar K, Veeraraghavaiah. Effect of tillage and herbicide use on weed management in maize (*Zea mays* L.). Andhra Agricultural Journal. 2011;58(2):123-125.
18. Sticker FC, Wearden S, Paul AW. Leaf area determination in grain sorghum. Agronomy Journal. 1961;53:187-188.
19. Walia US, Surjit Singh, Buta Singh. Integrated control of hardy weeds in maize (*Zea mays* L.). Indian Journal of Weed Science. 2007;39(1-2):17-20.
20. Watson DJ. The physiological basis of variation in yield. Advances in Agronomy. 1952;4:101-145.