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Nitin Singh
Department of Agronomy, Acharya
Narendra Deva University of
Agriculture and Technology,
Ayodhya, Uttar Pradesh, India

Anil Kumar Singh
Department of Agronomy, Acharya
Narendra Deva University of
Agriculture and Technology,
Ayodhya, Uttar Pradesh, India

Ram Lakhan Soni
Department of Soil Science, Acharya
Narendra Deva University of
Agriculture and Technology,
Ayodhya, Uttar Pradesh, India

Rituraj
Department of Soil Conservation &
Water Management, Chandra
Shekhar Azad University of
Agriculture & Technology, Kanpur,
Uttar Pradesh, India

Prashant Narayan
Department of Soil Science, Acharya
Narendra Deva University of
Agriculture and Technology,
Ayodhya, Uttar Pradesh, India

Vinayak Kumar Maurya
Department of Soil Science, Chandra
Shekhar Azad University of
Agriculture & Technology, Kanpur,
Uttar Pradesh, India

Deepak Kumar
Department of Soil Science, Acharya
Narendra Deva University of
Agriculture and Technology,
Ayodhya, Uttar Pradesh, India

Shivendra Kumar Singh
Department of Soil Science, Acharya
Narendra Deva University of
Agriculture and Technology,
Ayodhya, Uttar Pradesh, India

Corresponding Author:
Shivendra Kumar Singh
Department of Soil Science, Acharya
Narendra Deva University of
Agriculture and Technology,
Ayodhya, Uttar Pradesh, India

Residual effect of herbicides applied in wheat on the succeeding crop maize (*Zea mays* L.) and its associated weeds

**Nitin Singh, Anil Kumar Singh, Ram Lakhan Soni, Rituraj, Prashant
Narayan, Vinayak Kumar Maurya, Deepak Kumar and Shivendra Kumar
Singh**

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Abstract

A field experiment was conducted during the kharif season of 2022 at the Research Farm, A.N.D. University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.), on "Residual effect of herbicides applied in wheat on the succeeding crop maize (*Zea mays* L.) and its associated weeds." The experiment was conducted in Randomized Block Design and replicated three times comprised of seven treatments viz, Triallate 50% EC Pre emergence @1000 gm, Triallate 50% EC Pre emergence @1250 gm, Triallate 50% EC Pre emergence @1500 gm, Triallate 50% EC Pre emergence @ 2500 gm, Standard check Post emergence Clodinafop Propargyl 15% + metsulfuron Methyl 20% WP 60 gm + 4 gm ha¹, Hand weeding at 20 and 40 days after sowing (DAS), Control. Weed density, weed dry weight, weed index, and Nitrogen, phosphorus, and potassium uptake by weeds were lowest in Hand weeding twice at 20 and 40 DAS. Weed control efficiency was highest in Hand weeding twice at 20 and 40 DAS. Hand weeding twice at 20 and 40 DAS was most suitable for improving growth and yield of kharif maize, followed by post-emergence application of the standard check: Post-emergence Clodinafop Propargyl 15% + metsulfuron Methyl 20% WP 60 gm +4 gm ha¹.

Keywords: Herbicide residue, Wheat, Maize (*Zea mays* L.), Weed management, Weed control efficiency

Introduction

Maize (*Zea mays* L.) is one of the most adaptable crops, with a wide range of agro-climatic tolerance. Because it has the largest genetic yield potential of all the cereals, maize is referred to as the "queen of cereals" (Singh *et al.*, 2015) [9]. It accounts for 39% of the world's grain production and is grown on about 190 million acres in about 165 nations, across a wide range of soils, temperatures, biodiversity, and management techniques. The biggest issue affecting maize yield reduction is weeds (either rabi or kharif maize). There are several ways to control weeds in maize, including manual weed control, chemical weed control, and integrated weed control (Rani *et al.*, 2020) [7]. Among these, the chemical approach is the most cost-effective, effective, time-saving, and yield-enhancing method. The development and yield of rabi maize are affected by various weed types, including broadleaved weeds, grasses, and sedges. Several chemicals, such as pre-emergence herbicides (atrazine, pendimethalin, etc.) and post-emergence herbicides (2,4-D), are used to manage these weeds. Farmers currently use atrazine (1.0 kg/ha) as a pre-emergence herbicide and 2,4-D (1.0 kg/ha) as a post-emergence herbicide on maize (Barua *et al.*, 2019) [1]. It is also well known that atrazine's persistence in soil causes lingering effects. Many strategies, including mechanical, cultural, biological, and chemical management methods, are available to reduce weed losses. Farmers are turning to other alternative weed management techniques because cultural methods are no longer working for them. Chemical weed management may be thought of as the best choice in this regard. Chemical control methods are quicker, more efficient, and labor- and time-saving than other methods (Basu, S. & Rao, Y. V., 2020) [2].

Materials and Methods

The Present Study entitled “Residual effect of herbicides applied in wheat on the succeeding crop maize (*Zea mays* L.) and its associated weeds” comprises a field study which was conducted at the Agronomy Research Farm of Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, U.P. The farm is situated in the main campus of the university on Ayodhya-Raebareli Road at a distance of about 42 Km from Ayodhya district headquarters. The climate of the area is sub-humid to sub-tropical with an average annual rainfall of around 1100 mm. of this, about 85% of the total rainfall is received from the south-west monsoon during the months of June to September. However, occasional mild rains occur during winter. The weekly mean minimum and maximum temperatures during the crop season ranged from 21 °C to 41.9 °C and 10.1 °C to 38.5 °C, respectively. The total rainfall received was 735.4 mm during the entire crop season. The relative humidity (R.H.), Weekly Total evaporation and sunshine hours varied from 56.6 to 85.4%, 14.2 to 45.8 mm and 1.4 to 9.3 hrs, respectively.

The experiment was laid out in a randomized block design with the residual effect of herbicides applied in wheat on the succeeding crop, maize (*Zea mays* L.) and its associated weeds; Net plot size was 8.4x5.7 m² for the crop. The uniform seed rate of 25 kg ha⁻¹ was used in all the treatments. The variety used was “Kanchan”. The basal dose of fertilizer was applied in the respective plots according to treatment allocation with uniform mixing or fertilizer in the field. All the agronomic practices were carried out uniformly to raise the crop. The crop was harvested in October. Treatment combinations include: T₁- Triallate 50% EC pre-emergence (1000g), T₂- Triallate 50% EC pre-emergence (1250g), T₃- Triallate 50% EC pre-emergence (1500g), T₄- Triallate 50% EC pre-emergence (2500g), T₅- Standard Check Post emergence Clodinafop Propargyl 15%+ Metsulfuron Methyl 20% WP (60 gm/4 gm /ha), T₆- Hand weeding at 20 and 40 days after sowing (DAS), T₇- Control. Weed density, weed dry weight, weed index, and Nitrogen, phosphorus, and potassium uptake were analysed and assessed.

Result and Discussion

Weed density

Weed density at 30 DAS

The data presented in Table 1 show that weed density at 30 DAS, the weedy check (T₇) recorded significantly higher density of weeds, which was at par with the Triallate 50% mEC pre-emergence @ 1000 gm(T₁), Triallate50% EC pre-emergence@ 2500 gm(T₄), and Triallate 50% EC pre-emergence @ 1500 gm(T₃), while being significantly higher than the rest of the treatments under study. The lowest density of weeds was recorded under Hand weeding twice at 20 and 40 DAS (T₆), followed by Standard Check post-emergence clodinafop Propargyl 15% + Metsulfuron Methyl 20%WP @ 60 gm+4 gm/ha(T₅). Same trend as fallows under 30-day weed species.

Weed density at 60 DAS

The data presented in Table 2 show that weed density at 60 DAS, significantly higher density of weeds was recorded under weedy check (T₇), recorded significantly higher density of weeds, which was at par with the Triallate 50% mEC Pre emergence @ 1000 gm(T₁), Triallate50% EC pre-emergence@ 2500 gm(T₄) and Triallate 50% EC Pre emergence @ 1500 gm (T₃) while significantly higher over rest of the treatments under study. The lowest density of weeds was recorded under Hand weeding twice at 20 and 40 DAS (T₆), followed by Standard Check post-emergence clodinafop Propargyl 15% + Metsulfuron Methyl

20%WP@60gm+4 gmha-1 (T₅). Same trend as fallows under 60-day weed species.

Weed density at 90 DAS

The data presented in Table 3 show that weed density at 90 DAS in the weedy check (T₇) recorded a significantly higher density of weeds, which was at par with the Triallate 50% mEC pre-emergence @ 1000 gm(T₁), Triallate50% EC pre-emergence@ 2500 gm(T₄), and Triallate 50% EC pre-emergence @ 1500 gm(T₃), while significantly higher than the rest of the treatments under study. The lowest density of weeds was recorded under Hand weeding twice at 20 and 40 DAS (T₆), followed by Standard Check post-emergence clodinafop Propargyl 15% + Metsulfuron Methyl 20%WP@60gm+4 gm/ha(T₅). Same trend as fallows under 90 days weed species.

Weed density at Harvest

The data presented in Table 4 show that weed density at harvest in the weedy check (T₇) recorded significantly higher density of weeds, which was at par with the Triallate 50% mEC pre-emergence @ 1000 gm(T₁), Triallate50% EC pre-emergence@ 2500 gm(T₄), and Triallate 50% EC pre-emergence @ 1500 gm(T₃), while significantly higher than the rest of the treatments under study. The lowest density of weeds was recorded under Hand weeding twice at 20 and 40 DAS (T₆) followed by Standard Check post-emergence clodinafop Propargyl 15% + Metsulfuron Methyl 20%WP@60gm+4 gmha-1(T₅). Same trend as fallows under the weed species at the harvest stage. Similar result reported by Saeed *et al.* (2012) [8].

Weed dry weight (g m⁻²) at 30,60,90 DAS and at harvest.

Data pertaining to dry weight of weeds in summer maize as affected by different weed control treatments recorded at different growth stages have been presented in Table 5. In general, weed dry weight increased successively irrespective of treatments up to the harvest stage of the crop. It is evident from the data that at the 30 DAS stage, weedy check (T₇) recorded significantly higher weed dry weight as compared to the rest of the treatments under study. The lowest weed dry weight was recorded under Hand weeding twice at 20 and 40 DAS(T₆), followed by Standard Check post-emergence clodinafop Propargyl 15% + Metsulfuron Methyl 20%WP@60gm+4 gmha-1 (T₅). Similar trends were obtained at the rest of the stages. Higher weed dry weight at all stages obtained under the weedy check over the rest of the treatments might be due to a higher weed population of broad-leaved weeds and sedges, which ultimately led to higher weed dry weight under the treatment. The lowest dry weight of weeds was obtained with hand weeding twice at 20 and 40 DAS (T₆), followed by standard check post-emergence clodinafop Propargyl 15% + Metsulfuron Methyl 20%WP@60gm+4 gmha-1 (T₅), possibly due to lowest crop weed competition for available growth resources, viz. moisture, nutrients, light and space, which led to reduction in population of weeds such as broad-leaved weeds and sedges. Similar results were obtained by Rajablarijani *et al.* 2014) [6].

Weed Index (%)

Data about weed index of Kharif maize as affected by different weed control treatments have been presented in Table 6. It is obvious from the data that highest weed index with value of (34.96%) was obtained under weedy check (T₇) as compared to weed free plot while the lowest Weed index by (3.52%) was obtained in Standard Check Post emergence clodinafop Propargyl 15% + Metsulfuron Methyl 20%WP@60gm+4 gmha-1 (T₅)

Higher reduction in yield obtained in weedy check as compared to weed free plot might be due to higher crop weed competition for growth resources which reflected in term of higher weed index. The lowest weed index was obtained in Standard Check post-emergence clodinafop Propargyl 15% + Metsulfuron Methyl 20%WP@60gm+4 gmha-1 (T₅) as a result of satisfactory control of weeds owing to reduction in crop-weed competition. Similar results were obtained by Vidotto *et al.* (2016) ^[10].

Nutrient uptake by weed

Nitrogen uptake by weeds (kg ha⁻¹)

Data about Nitrogen uptake by weeds (kg ha⁻¹) of Kharif maize as affected by different weed control treatments have been presented in Table 7. Among different treatments, Hand weeding twice at 20 and 40 DAS (T₆) recorded significantly lower uptake of Nitrogen as compared to all the treatments except Standard Check post-emergence clodinafop Propargyl 15% + Metsulfuron Methyl 20%WP@60gm+4 gmha-1 (T₅) and Triallate 50% EC Pre emergence@1250 gm (T₂). However, significantly higher uptake of Nitrogen was obtained under the weedy check (T₇) over the rest of the treatments, except Triallate 50% EC Pre emergence@ 1000 g (T₁). Similar results were obtained by Haji *et al.* (2011) ^[5]

Phosphorus uptake by weed (kg ha⁻¹).

Data about Phosphorus uptake by weeds (kg ha⁻¹) of Kharif maize as affected by different weed control treatments have been presented in Table 7. Highest Phosphorous uptake was recorded

under weedy check (T₇) followed by Triallate 50% EC Pre emergence@1000 gm (T₁), which was significantly higher over Triallate 50% EC Pre emergence@1000 gm (T₁), and Triallate 50% EC Pre emergence@1500 gm (T₃), Hand weeding twice at 20 and 40 DAS (T₆) while at par with rest of the treatments under study and the lowest Phosphorus uptake was obtained under Hand weeding twice at 20 and 40 DAS (T₇) followed by Standard Check Post emergence clodinafop Propargyl 15% + Metsulfuron Methyl 20%WP@60gm+4 gmha-1 (T₅).

Potassium uptake by weeds (kg ha-1)

Data on potassium uptake by weeds (kg ha-1) in Kharif maize under different weed control treatments are presented in Table 7. Higher potassium uptake was observed under the weedy check (T₇), which was significantly higher than that under the other treatments. The lowest potassium uptake by weeds was recorded under hand weeding twice at 20 and 40 DAS (T₆), followed by the standard check, post-emergence clodinafop propargyl 15% + metsulfuron methyl 20% WP @ 60 gm + 4 gm ha-1 (T₅). Higher nutrient uptake, viz., nitrogen, phosphorus, and potassium, by weeds was recorded under the weedy check (T₇) due to a severe weed population, which led to higher nutrient uptake by weeds in this treatment. The lowest nutrient uptake by weeds was recorded under hand weeding twice at 20 and 40 DAS (T₇) due to the lowest weed population and dry weight of weeds. A similar result was reported by Chauhan *et al.* (2019) ^[3].

Table 1: Residual effect of weed control Treatments on weed density of various weed (m⁻²) of kharif maize at 30 DAS

T. No	Treatment details	<i>Commelia benghalensis</i>	<i>Amaranthus viridis</i>	<i>Ageratum conyzoides</i>	<i>Digitaria sanguinalis</i>	<i>Echinochloa colonum</i>	<i>Cyperus rotundus</i>	<i>Eleusine indica</i>	<i>Phyllanthus niruri</i>	Others	Total
T ₁	Triallate 50% EC Premergergence@ 1000 gm	5.05 (25.00)	4.25 (17.60)	3.62 (12.60)	4.63 (21.00)	3.92 (14.90)	5.60 (30.90)	4.80 (22.50)	3.16 (9.50)	3.38 (10.90)	12.86 (164.90)
T ₂	Triallate 50% EC Pre emergence@ 1250 gm	4.63 (21.00)	3.90 (14.70)	3.32 (10.50)	4.25 (17.60)	3.60 (12.50)	5.15 (26.00)	4.40 (18.90)	2.91 (8.00)	3.11 (9.20)	11.78 (138.40)
T ₃	Triallate 50% EC Pre emergence@ 1500 gm	4.77 (22.30)	4.00 (15.50)	3.41 (11.10)	4.36 (18.50)	3.67 (13.00)	5.27 (27.30)	4.52 (20.0)	2.98 (8.40)	3.19 (9.70)	12.09 (145.80)
T ₄	Triallate 50% EC Pre emergence@ 2500 gm	4.89 (23.50)	4.11 (16.40)	3.51 (11.80)	4.49 (19.70)	3.82 (14.10)	5.45 (29.20)	4.66 (21.2)	3.08 (9.00)	3.28 (10.30)	12.48 (155.20)
T ₅	Standard Check Post emergence Clodinafop Propargyl15% + Metsulfuron Methyl20%WP 60 gm + 4 gm/ha	2.21 (4.40)	1.61 (2.10)	1.67 (2.30)	1.97 (3.40)	1.55 (1.90)	3.16 (9.50)	2.81 (7.40)	2.53 (5.90)	1.73 (2.50)	6.32 (39.40)
T ₆	Hand weeding at 20 and 40 days after sowing (DAS)	1.61 (2.10)	1.41 (1.50)	1.34 (1.30)	1.61 (2.10)	1.34 (1.30)	2.61 (6.30)	2.41 (5.30)	2.17 (4.20)	1.48 (1.70)	5.13 (25.80)
T ₇	Weedy check	5.50 (29.80)	4.41 (19.00)	3.81 (14.00)	4.95 (24.00)	4.34 (18.30)	6.32 (39.50)	5.11 (25.60)	3.39 (11.00)	3.69 (13.10)	13.95 (194.30)
	SEm±	0.10	0.08	0.04	0.08	0.06	0.10	0.07	0.06	0.05	0.19
	CD at 5%	0.30	0.25	0.12	0.24	0.17	0.30	0.23	0.18	0.16	0.57

Table 2: Residual effect of weed control Treatments on weed density of various weed (m⁻²) of kharif maize at 60 DAS

T. No	Treatment details	<i>Commelia benghalensis</i>	<i>Amaranthus viridis</i>	<i>Ageratum conyzoides</i>	<i>Digitaria sanguinalis</i>	<i>Echinochloa colonum</i>	<i>Cyperus rotundus</i>	<i>Eleusine indica</i>	<i>Phyllanthus niruri</i>	Others	Total
T ₁	Triallate 50% EC Premergergence@ 1000 gm	5.48 (29.50)	4.59 (20.60)	3.89 (14.60)	5.02 (24.70)	4.24 (17.50)	6.08 (36.50)	5.19 (26.40)	3.40 (11.10)	3.67 (13.00)	13.93 (193.90)
T ₂	Triallate 50% EC Pre emergence@ 1250 gm	5.02 (24.70)	4.22 (17.30)	3.51 (11.80)	4.61 (20.80)	3.88 (14.60)	5.57 (30.50)	4.74 (22.00)	3.13 (9.30)	3.45 (11.40)	12.77 (162.80)
T ₃	Triallate 50% EC Pre emergence@ 1500 gm	5.14 (26.00)	4.31 (18.10)	3.59 (12.40)	4.72 (21.80)	4.00 (15.50)	5.69 (31.90)	4.85 (23.10)	3.19 (9.70)	3.43 (11.30)	13.05 (170.20)
T ₄	Triallate 50% EC Pre emergence@ 2500 gm	5.32 (27.80)	4.44 (19.20)	3.70 (13.20)	4.88 (23.30)	4.10 (16.30)	5.87 (34.00)	5.00 (24.50)	3.29 (10.30)	3.56 (12.20)	13.48 (181.20)
T ₅	Standard Check Post emergence Clodinafop Propargyl15% + Metsulfuron Methyl20%WP 60 gm + 4 gm/ha	2.51 (5.80)	1.76 (2.60)	1.92 (3.20)	2.34 (5.00)	1.70 (2.40)	3.65 (12.80)	3.62 (12.60)	3.30 (10.40)	2.59 (6.20)	7.76 (59.80)

T ₆	Hand weeding at 20 and 40 days after sowing (DAS)	1.70 (2.40)	1.30 (1.20)	1.30 (1.20)	1.70 (2.40)	1.30 (1.20)	2.75 (7.10)	2.55 (6.00)	2.28 (4.70)	1.55 (1.90)	5.35 (28.10)
T ₇	Weedy check	6.53 (42.10)	5.23 (26.90)	4.54 (20.16)	5.86 (33.90)	5.14 (25.90)	7.51 (55.90)	6.06 (36.20)	4.01 (15.60)	4.36 (18.50)	16.59 (274.80)
	SEm±	0.09	0.09	0.04	0.09	0.06	0.11	0.08	0.06	0.06	0.24
	CD at 5%	0.29	0.28	0.14	0.26	0.19	0.34	0.25	0.20	0.17	0.75

Table 3: Residual effect of weed control Treatments on weed density (m⁻²) of various weeds in kharif maize at 90 DAS

T. No	Treatment details	<i>Commelia benghalensis</i>	<i>Amaranthus viridis</i>	<i>Ageratum conyzoides</i>	<i>Digitaria sanguinalis</i>	<i>Echinochloa colonum</i>	<i>Cyperus rotundus</i>	<i>Eleusine indica</i>	<i>Phyllanthus niruri</i>	Others	Total
T ₁	Triallate 50% EC Premergence@ 1000 gm	5.97 (35.20)	5.02 (24.70)	4.16 (16.80)	5.49 (29.70)	4.61 (20.80)	6.63 (43.50)	5.66 (31.50)	3.70 (13.20)	4.00 (15.50)	15.22 (231.40)
T ₂	Triallate 50% EC Pre emergence@ 1250 gm	5.48 (29.50)	4.59 (20.60)	3.83 (14.20)	5.02 (24.90)	4.24 (17.50)	6.08 (36.50)	5.19 (26.40)	3.38 (10.90)	3.67 (13.00)	13.93 (193.90)
T ₃	Triallate 50% EC Pre emergence@ 1500 gm	5.60 (30.90)	4.70 (21.60)	3.91 (14.80)	5.15 (26.00)	4.34 (18.30)	6.21 (38.10)	5.32 (27.80)	3.43 (11.30)	3.78 (13.80)	14.26 (203.00)
T ₄	Triallate 50% EC Pre emergence@ 2500 gm	5.78 (33.00)	4.86 (23.10)	4.06 (16.00)	5.34 (28.00)	4.48 (19.60)	6.43 (40.80)	5.48 (29.50)	3.56 (12.20)	3.86 (14.40)	14.74 (217.10)
T ₅	Standard Check Post emergence Clodinafop Propargyl15% + Metsulfuron Methyl20%WP 60 gm + 4 gm/ha	2.43 (5.40)	1.64 (2.20)	1.84 (2.90)	2.30 (4.80)	1.64 (2.20)	3.39 (11.00)	3.29 (10.30)	3.08 (9.00)	2.49 (5.70)	7.24 (52.00)
T ₆	Hand weeding at 20 and 40 days after sowing (DAS)	1.58 (2.00)	1.22 (1.00)	1.52 (1.80)	1.52 (1.80)	1.22 (1.00)	3.18 (9.60)	2.39 (5.20)	2.12 (4.00)	1.79 (2.70)	5.45 (29.20)
T ₇	Weedy check	6.87 (46.70)	5.50 (29.70)	4.78 (22.32)	6.17 (37.60)	5.39 (28.60)	7.89 (61.80)	6.37 (40.10)	4.20 (17.20)	4.58 (20.50)	17.45 (304.10)
	SEm±	0.09	0.03	0.06	0.05	0.07	0.08	0.05	0.05	0.06	0.27
	CD at 5%	0.28	0.08	0.19	0.15	0.21	0.24	0.14	0.17	0.19	0.85

Table 4: Residual effect of weed control Treatments on weed density (m⁻²) of various weeds in kharif maize at Harvest

T. No	Treatment details	<i>Commelia benghalensis</i>	<i>Amaranthus viridis</i>	<i>Ageratum conyzoides</i>	<i>Digitaria sanguinalis</i>	<i>Echinochloa colonum</i>	<i>Cyperus rotundus</i>	<i>Eleusine indica</i>	<i>Phyllanthus niruri</i>	Others	Total
T ₁	Triallate 50% EC Premergence@ 1000 gm	5.60 (30.90)	4.68 (21.40)	3.91 (14.80)	5.16 (26.20)	4.34 (18.30)	6.21 (38.10)	5.30 (27.60)	3.46 (11.50)	3.75 (13.60)	14.25 (202.80)
T ₂	Triallate 50% EC Pre emergence@ 1250 gm	5.13 (25.80)	4.31 (18.10)	3.59 (12.40)	4.72 (21.80)	4.00 (15.50)	5.69 (31.90)	4.86 (23.10)	3.16 (9.50)	3.43 (11.30)	13.04 (169.80)
T ₃	Triallate 50% EC Pre emergence@ 1500 gm	5.24 (27.00)	4.41 (19.00)	3.67 (13.00)	4.84 (22.90)	4.10 (16.30)	5.82 (33.40)	4.96 (24.10)	3.25 (10.10)	3.52 (11.90)	13.36 (178.10)
T ₄	Triallate 50% EC Pre emergence@ 2500 gm	5.41 (28.80)	4.55 (20.20)	3.79 (13.90)	4.98 (24.30)	4.22 (17.30)	6.01 (35.60)	5.13 (25.80)	3.33 (10.60)	3.64 (12.80)	13.78 (189.70)
T ₅	Standard Check Post emergence Clodinafop Propargyl15% + Metsulfuron Methyl20%WP 60 gm + 4 gm/ha	2.39 (5.20)	1.64 (2.20)	1.76 (2.60)	2.26 (4.60)	1.58 (2.00)	3.27 (10.20)	3.21 (9.80)	3.02 (8.60)	2.28 (4.70)	7.00 (48.50)
T ₆	Hand weeding at 20 and 40 days after sowing (DAS)	1.70 (2.40)	1.58 (2.00)	1.45 (1.60)	1.52 (1.80)	1.22 (1.00)	1.87 (3.00)	2.34 (5.00)	2.12 (4.00)	1.61 (2.10)	4.84 (22.90)
T ₇	Weedy check	6.55 (42.50)	5.24 (27.00)	4.54 (20.09)	5.89 (34.20)	5.15 (26.00)	7.53 (56.20)	6.08 (36.50)	4.01 (15.60)	4.37 (18.60)	16.63 (276.50)
	SEm±	0.10	0.08	0.06	0.10	0.06	0.11	0.09	0.07	0.05	0.25
	CD at 5%	0.30	0.25	0.17	0.30	0.18	0.33	0.28	0.21	0.16	0.78

Table 5: Residual effect of herbicide on weed dry weight (g -2) and weed index

T. No.	Treatment details	Weed dry weight (g m-2)			
		30 DAS	60 DAS	90 DAS	At harvest
T ₁	Triallate 50% EC Pre emergence@1000 gm	7.07 (49.47)	13.59 (184.21)	17.68 (312.39)	16.74 (279.86)
T ₂	Triallate 50% EC Pre emergence@1250 gm	6.48 (41.52)	12.45 (154.66)	16.19 (261.77)	15.32 (234.32)
T ₃	Triallate 50% EC Pre emergence@1500 gm	6.65 (43.74)	12.73 (161.59)	16.57 (274.05)	15.69 (245.78)
T ₄	Triallate 50% EC Pre emergence@2500 gm	6.86 (46.56)	13.13 (172.14)	17.13 (293.09)	16.19 (261.79)
T ₅	Standard Check Post-emergence Clodinafop Propargyl 15% +Metsulfuron Methyl 20%WP 60 gm + 4 gm ha ⁻¹	3.51 (11.82)	7.57 (56.81)	8.40 (70.20)	8.21 (66.93)
T ₆	Hand weeding at 20 and 40 days after sowing (DAS)	2.87 (7.74)	5.21 (26.70)	6.31 (39.42)	5.66 (31.60)
T ₇	Weedy check	7.67 (58.29)	15.63 (244.00)	20.26 (410.54)	19.54 (381.57)
	SEm ±	0.12	0.21	0.31	0.29
	CD at 5%	0.37	0.66	0.95	0.90

Table 6: Residual effect of herbicide on Weed Index (%)

T. No.	Treatment details	Weed Index%
T ₁	Triallate 50% EC Pre emergence@1000 gm	25.98
T ₂	Triallate 50% EC Pre emergence@1250 gm	15.43
T ₃	Triallate 50% EC Pre emergence@1500 gm	18.36
T ₄	Triallate 50% EC Pre emergence@2500 gm	23.05
T ₅	Standard Check Post emergence Clodinafop Propargyl 15% + MetsulfuronMethyl 20%WP 60 gm + 4 gm ha ⁻¹	3.52
T ₆	Hand weeding at 20 and 40 days after sowing (DAS)	0.00
T ₇	Weedy check	34.96
	SEm±	0.67
	CD at 5%	2.08

Table 7. Residual effect of herbicide on Nutrient uptake by weed (kg/ha)

S. NO	Treatments	Nutrient uptake by weed (kg/ha)		
		Nitrogen	Phosphorus	Potassium
T ₁	Triallate 50% EC Pre emergence@1000 gm	22.11	4.20	35.82
T ₂	Triallate 50% EC Pre emergence@1250 gm	18.28	3.28	29.99
T ₃	Triallate 50% EC Pre emergence@1500 gm	19.17	3.44	31.46
T ₄	Triallate 50% EC Pre emergence@2500 gm	20.68	3.67	33.51
T ₅	Standard Check Post-emergence Clodinafop Propargyl 15% + Metsulfuron Methyl 20%WP 60 gm + 4 gm ha ⁻¹	5.22	0.87	8.50
T ₆	Hand weeding at 20 and 40 days after sowing (DAS)	2.43	0.41	4.01
T ₇	Weedy check	30.14	5.72	49.22
	SEm ±	0.87	0.15	1.15
	CD at 5%	2.67	0.47	3.56

Conclusion

Based on the results of the present investigation, it can be concluded that T₆ (Hand weeding at 20 and 40 days after sowing (DAS)) was the most effective in improving yield because the weed density was low in this treatment, and the effects of T₇ (Weedy Check) on weed dry weight and weed index were controlled more efficiently by T₇ than the other treatments. Considering the superior performance in terms of N, P, and K uptake, T₇ (Weedy check) shows better results because the uptake in grain was superior with respect to other treatments.

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