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# STUDIES ON COMPARATIVE BIOEFFICACY OF PRE AND POST EMERGENCE HERBICIDE ON GARLIC (*ALLIUM SATIVUM* L.) CROP

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**ABSTRACT**

The present investigation entitled "Studies on comparative bioefficacy of pre and post emergence herbicide on Garlic (*Allium sativum* L.)" was conducted during the *rabi* season of 2024-25 at the All India Coordinated Research Project on Vegetable Crops, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra. The experiment comprised ten treatments including pre- and post-emergence applications of Oxyfluorfen, Pendimethalin, Propaquizafop + Oxyfluorfen combinations, a weedy check, and a weed-free check, laid out in Randomized Block Design with three replications. The results revealed that all weed management treatments significantly reduced weed density and dry weight over the weedy check. The minimum weed population, dry weight, and weed index along with the highest weed control efficiency were observed in the weed-free check ($T_{10}$), closely followed by Pendimethalin 580 g a.i./ha (PE) + hand weeding at 45 DAP ($T_4$). Growth parameters such as plant height and number of leaves per plant, as well as yield attributes including average bulb weight and total garlic yield, were also highest in the weed-free treatment, while $T_4$ proved significantly superior among herbicidal treatments. The lowest values for growth and yield characters were recorded in the weedy check ($T_9$). Economic analysis indicated that the weed-free treatment ($T_{10}$) recorded the highest net monetary returns (Rs. 3,55,000 $ha^{-1}$) and B:C ratio (2.79). Among the herbicidal treatments, $T_4$ registered maximum net monetary returns (Rs. 3,03,282 $ha^{-1}$) and B:C ratio (2.59), while the weedy check was uneconomical. It may therefore be concluded that Pendimethalin 580 g a.i./ha (PE) in combination with hand weeding at 45 DAP is effective for controlling weeds, improving growth and yield, and enhancing economic returns in garlic cultivation under Rahuri conditions. However, multi-season validation is necessary to confirm the consistency of these results.

***Keywords*:** Garlic, Pre emergence, Post emergence, Pendimethalin, Weed control efficiency, Yield

## Introduction

Garlic (*Allium sativum* L.) is an important bulbous spice crop cultivated worldwide for its distinctive flavour, nutritional value, and medicinal properties. India is the second largest producer after China, contributing about 10% of global garlic production. Within India, Madhya Pradesh is the leading producer followed by Rajasthan, Uttar Pradesh, and Gujarat, with Mandsaur recognized as the country's largest garlic market. In Maharashtra too, garlic is widely cultivated, contributing significantly to the spice economy. Despite its economic importance, garlic is highly vulnerable to weed infestation due to its slow initial growth, sparse foliage, shallow root system, and frequent irrigation requirements (Rahman *et al*., 2012). Weeds compete with garlic for nutrients, moisture, light, and space, and also act as alternate hosts for pests and diseases. Yield losses due to weed competition have been reported to range from 30-60% (Lawande *et al*., 2009) and up to 40-80% in severe cases (Verma and Singh, 1996). Mechanical or manual weeding in garlic is difficult because of its close planting and

shallow roots, often causing damage to developing bulbs. Moreover, these methods are labour-intensive, costly, and sometimes delayed due to labour scarcity or unfavourable weather conditions. Hence, manual weed management is less efficient and economically unviable for farmers. Although chemical weed control in garlic has received limited research attention, herbicides offer a practical, effective, and economical alternative to manual weeding. Their integration in production systems not only reduces crop-weed competition during the critical stages of growth but also enhances bulb yield. Therefore, the present investigation entitled "Studies on comparative bioefficacy of pre and post emergence herbicide on Garlic (*Allium sativum* L.) crop was undertaken to evaluate the bio- efficacy of pre and post-emergence herbicides on weed control efficiency, growth, and yield of garlic under field conditions.

## Materials and Methods

The present investigation entitled "Studies on comparative bioefficacy of pre and post emergence herbicide on Garlic (*Allium sativum* L.)" was conducted during the Rabi season of 2024-25 at the All India Coordinated Research Project on Vegetable Crops, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra. The experiment was laid out in a Randomized Block Design (RBD) with three replications and comprised ten treatments consisting of combinations of pre-emergence and post- emergence herbicides, alongside a weedy and a weed-free check. The crop used was garlic (*Allium sativum* L.), variety Phule Nilima, planted on 26$^{th}$ October 2024 with a plot size of 5.0 × 1.5 m² and plant spacing of 15 cm between rows and 10 cm between plants. The treatment details were as follows: T1 - Oxyfluorfen 23.5% EC, 175 g a.i/ha (PE) and Oxyfluorfen 23.5% EC, 175 g a.i/ha (PoE), T2 - Oxyfluorfen 23.5% EC, 175 g.a.i./ha (PE) and hand weeding at 45 DAP, T3 - Pendimethalin 580 g.a.i./ha (PE) and Pendimethalin 580 g.a.i./ha (PoE), T4 - Pendimethalin 580 g.a.i./ha (PE) and hand weeding at 45 DAP, T5 - Propaquizafop 5% 43.75 g.a.i./ha + Oxyfluorfen 12% ww/EC 175 g.a.i./ha (PE) and Propaquizafop 5% 43.75 g.a.i./ha + Oxyfluorfen 12% ww/EC 175 g.a.i./ha (PoE), T6 - Propaquizafop 5% 55.75 g.a.i./ha + Oxyfluorfen 12% ww/EC (PE) and Propaquizafop 5% 55.75 g.a.i./ha + Oxyfluorfen 12% ww/EC (PoE), T7 - Propaquizafop 5% 43.75 g.a.i./ha + Oxyfluorfen 12% ww/EC 175 g.a.i./ha (PE) and hand weeding at 45 DAP, T8 - Propaquizafop 5% 55.75 g.a.i./ha + Oxyfluorfen 12% ww/EC (PE) and hand weeding at 45 DAP, T9 - Control (Weedy Check), T10 - Weed free check. The recommended package of practice was undertaken for conduct of experiment. Observations recorded included growth and yield parameters such as plant height, number of leaves per plant, average bulb weight, bulb diameter and length, average weight of 10 cloves, number of cloves per bulb, total bulb yield (q/ha), and marketable bulb yield (q/ha). Weed parameters included species-wise weed count (monocots, dicots, sedges) at 30, 60, 90, and 120 days after planting (DAP) and at harvest from 1×1 m² quadrats, fresh and dry weight of weeds per m², weed control efficiency (%), weed index (%), weed management index (%), and herbicide efficiency index (%). Phytotoxicity symptoms were observed at 0, 3, 5, 7, and 10 days after spray on randomly selected plants. The incidence of diseases including Stemphylum blight and purple blotch was recorded as percent leaf area infected using a disease rating scale from 0 to 5, following Gupta *et al.* (2011). Weed control efficiency was calculated as the per cent reduction in weed population in treated plots compared to the untreated control. Weed index was expressed as the percent reduction in yield in comparison to a weed-free treatment. Herbicide efficiency index and weed management index were calculated based on standard formulas from Sharma *et al*. (2009) and Sivamurugan *et al.* (2009). All the observations recorded were subjected to statistical analysis using Analysis of Variance (ANOVA) as per the Randomized Block Design method, and treatment means were compared by critical difference at the 5% level of significance following Panse and Sukhatme (1985).

## Results and Discussion

### Growth Parameters

Plant height at harvest was significantly influenced by the weed management strategies. The weed-free check (T10) recorded the highest average plant height of 57.66 cm. Treatment T4, combining Pendimethalin @ 580 g a.i/ha (pre-emergence) with hand weeding at 45 DAP, followed closely with 55.00 cm. These treatments provided optimal conditions by reducing competition for nutrients, moisture, light, and space. The untreated weedy check (T9) exhibited the lowest plant height at 43.33 cm, highlighting the detrimental impact of uncontrolled weeds on crop development. Similar findings were reported by Kamboj *et al*. (2022) and Turk and Tawaha (2002). The highest number of leaves per plant (10.00) was recorded under the weed-free treatment (T10). Treatments T4 and T7 recorded comparable results (9.80 and 9.47 leaves, respectively), while the untreated weedy check (T9) produced the fewest leaves (7.63).

These findings underscore the role of effective weed suppression in promoting vegetative growth, consistent with Siddhu *et al*. (2018) and Raj Kumar *et al.* (2017).

**Yield Parameters**

The highest average bulb weight was observed in the weed-free check (25.57 g), closely followed by T4 (25.13 g), T7 (24.63 g), and T6 (23.87 g). The untreated control (T9) recorded the lowest bulb weight (18.59 g). The reduced weed competition in treatments like T4 and T10 likely allowed garlic plants to allocate more resources towards bulb development, as reported by Mahmood *et al*. (2002) and Singh and Nandal (2002). The longest and widest bulbs were produced under the weed-free treatment (3.90 cm length and 3.67 cm diameter). Treatment T4 followed with 3.76 cm length and 3.48 cm diameter. The weedy check (T9) recorded the smallest bulb dimensions (3.28 cm length and 2.94 cm diameter), confirming that weed competition reduces bulb expansion. These results align with Singh *et al*. (2019) and Chauhan and Singh (2015). Treatment T10 recorded the highest number of cloves per bulb (26) and the highest average weight of 10 cloves (9.33 g). Treatment T4 also performed well (24.50 cloves and 8.73 g). The untreated weedy check (T9) showed the lowest values (21 cloves and 5.17 g). These observations are consistent with Sangani *et al*. (2024) and Muhammad *et al*. (2016). Total yield was highest under the weed-free treatment (191.49 q/ha), statistically similar to T4 (172.24 q/ha). The lowest yield was in the untreated weedy check (83.11 q/ha). Marketable yield followed a similar trend, with T10 at 184.33 q/ha and T4 at 164.33 q/ha. The yield improvements are attributed to effective weed control and reduced competition, in agreement with Shashidhar *et al*. (2013) and Patel *et al*. (2020).

**Weed parameters**

At all stages (30, 60, 90, 120 DAP, and harvest), Treatment $T_4$ (Pendimethalin pre-emergence + hand weeding) consistently recorded the lowest weed densities across monocots, dicots, and sedges. The untreated weedy check ($T_9$) exhibited the highest weed densities. Prominent weeds included *Cynodon dactylon* and *Cyperus rotundus* (monocots and sedges), and *Portulaca oleracea*, *Parthenium hysterophorus*, *Amaranthus spinosus*, *Euphorbia hirta*, and *Chenopodium album* (dicots). Treatment $T_4$ recorded the lowest fresh weed weight (17.37 g/m²) and dry weed weight (8.67 g/m²), followed by $T_7$ and $T_6$. The untreated weedy check ($T_9$) showed the highest weed biomass (127.00 g/m² fresh and 63.63 g/m² dry weight), indicating ineffective control in the absence of herbicide or manual interventions. These results are in line with Samnotra *et al*. (2014) and Mahmood *et al.* (2002). Weed Control Efficiency (WCE) ranged from 24.50% to 100%. The weed-free check ($T_{10}$) maintained 100% efficiency throughout, while Treatment $T_4$ achieved high WCE (77.78% at harvest), confirming the effectiveness of combining Pendimethalin and hand weeding. The untreated weedy check ($T_9$) showed 0% efficiency, consistent with the findings of Siddhu *et al*. (2018) and Sharma (2022). Treatment $T_4$ exhibited the lowest Weed Index (10.08%), indicating minimal yield loss due to weed competition. The highest weed index (57.22%) was seen in $T_9$, reflecting the maximum negative impact of uncontrolled weeds. These observations are supported by Walia *et al*. (2003) and Patel *et al*. (2011). The highest Herbicide Efficiency Index (HEI) was recorded in Treatment $T_4$ (10.08%), followed by $T_7$ and $T_6$. These treatments demonstrated efficient suppression of weeds and higher garlic yields compared to others. The weedy check ($T_9$) recorded an HEI of 0.00%, reinforcing the importance of weed control. Treatment $T_4$ recorded the highest Weed Management Index (7.22%), highlighting its superiority in managing weed populations and improving yield. This metric confirmed that integrating chemical and manual weed control is the most effective strategy, consistent with findings by Khokhar *et al*. (2005) and Sangani *et al*. (2024).

**Phytotoxicity Symptoms**

No phytotoxic effects (chlorosis, necrosis, hyponasty, epinasty, or yellowing) were observed in any of the herbicidal treatments, confirming crop safety at recommended dosages. These results agree with Patel *et al*. (2007) and Kumar *et al*. (2013).

**Economics**

The economic analysis revealed that weed management practices significantly influenced the profitability of garlic cultivation. The highest gross monetary return (Rs. 5,52,990/ha), net return (Rs. 3,55,000/ha), and benefit-cost (B:C) ratio (2.79) were obtained under the weed-free treatment (T10), owing to maximum yield. This was closely followed by Pendimethalin (580 g a.i./ha PE) + hand weeding at 45 DAP (T4), which recorded gross returns of Rs. 4,92,990/ha, net returns of Rs. 3,03,282/ha, and a B:C ratio of 2.59, making it the most profitable integrated weed management practice. Treatments involving Propaquizafop and Oxyfluorfen combinations (T6 and T7) also proved economically viable, with net returns above Rs. 2.60 lakhs/ha and B:C ratios of 2.42 and 2.38, respectively. While the weedy check (T9)

recorded the lowest returns (Rs. 43,000/ha) and B:C ratio (1.23) due to severe yield losses from unchecked weed competition. Overall, the results highlight that integrated weed management practices, particularly Pendimethalin + hand weeding, are both effective and economically sustainable, performing at par with weed-free conditions.

## Conclusion

The study revealed that weed management practices significantly affected growth, yield, pest and disease incidence, and economics of garlic (*Allium sativum* L.). The weed-free treatment recorded the highest growth parameters, yield but its labor-intensive nature limits large-scale application. Among the herbicidal treatments, Pendimethalin (580 g a.i./ha) as pre-emergence combined with hand weeding at 45 DAP proved most effective and economically viable, delivering results comparable to the weed-free check. This integrated approach offers a sustainable and efficient strategy for enhancing garlic productivity

**Table 1 :** Morphological characters of garlic as influenced by different weed control treatments in garlic crop

| Sr. No. | Treatments | Plant height at harves (cm) | No. of leaves/ plant (at harvest) | Average bulb weight (g) | Length of bulb (cm) | Diameter of bulb (cm) | Number of cloves / bulb | Average weight of 10 cloves (g) |
|---|---|---|---|---|---|---|---|---|
| $T_1$ | Oxyfluorfen 23.5% EC, 175 g a.i/ha (PE) and Oxyfluorfen 23.5% EC, 175 g a.i/ha (PoE) | 49.66 | 8.00 | 20.29 | 3.48 | 3.25 | 22.50 | 7.00 |
| $T_2$ | Oxyfluorfen 23.5% EC, 175 g.a.i/ha (PE) and hand weeding at 45 DAP | 50.66 | 8.23 | 21.03 | 3.53 | 3.29 | 22.87 | 7.07 |
| $T_3$ | Pendimethalin 580 g.a.i/ha (PE) and Pendimethalin 580 g.a.i/ha (PoE) | 51.33 | 8.33 | 21.50 | 3.56 | 3.33 | 22.98 | 7.20 |
| $T_4$ | Pendimethalin 580 g.a.i/ha (PE) 580 and hand weeding at 45 DAP. | 55.00 | 9.80 | 25.13 | 3.76 | 3.48 | 24.50 | 8.73 |
| $T_5$ | Propaquizafop 5% 43.75 g.a.i/ha + Oxyfluorfen 12% ww/EC 175 g.a.i/ha (PE) and Propaquizafop 5% 43.75 g.a.i/ha + Oxyfluorfen 12% ww/EC 175 g.a.i/ha (PoE) | 51.66 | 8.53 | 22.67 | 3.62 | 3.38 | 23.27 | 8.46 |
| $T_6$ | Propaquizafop 5% 55.75 g.a.i/ha + Oxyfluorfen 12% ww/EC (PE) and Propaquizafop 5% 55.75 g.a.i/ha + Oxyfluorfen 12% ww/EC (PoE) | 52.66 | 9.33 | 23.87 | 3.64 | 3.40 | 23.29 | 8.50 |
| $T_7$ | Propaquizafop 5% 43.75 g.a.i/ha + Oxyfluorfen 12% ww/EC 175 g.a.i/ha (PE) and hand weeding at 45 DAP | 53.66 | 9.47 | 24.63 | 3.69 | 3.44 | 23.67 | 8.60 |
| $T_8$ | Propaquizafop 5% 55.75 g.a.i/ha + Oxyfluorfen 12% ww/EC (PE) and hand weeding at 45 DAP | 51.43 | 8.37 | 22.10 | 3.58 | 3.34 | 23.00 | 7.33 |
| $T_9$ | Control (Weedy Check). | 43.33 | 7.63 | 18.59 | 3.28 | 2.94 | 21.00 | 5.17 |
| $T_{10}$ | Weed free (Check). | 57.66 | 10.00 | 25.57 | 3.90 | 3.67 | 26.00 | 9.33 |
| S.Em. ± | | 1.70 | 0.20 | 0.98 | 0.02 | 0.03 | 0.70 | 0.40 |
| CD at 5 % | | 5.00 | 0.60 | 2.91 | 0.07 | 0.09 | 1.90 | 1.10 |

**Table 2 :** Effect of different weed control treatments on weed parameters

| Sr. No. | Treatments | Fresh weight of weed (g) | Dry weight of weed (g) | Weed control efficiency (%) At harvest | WI (%) | HEI (%) | WMI (%) |
|---|---|---|---|---|---|---|---|
| $T_1$ | Oxyfluorfen 23.5% EC, 175 g a.i/ha (PE) and Oxyfluorfen 23.5% EC, 175 g a.i/ha (PoE) | 76.67 (8.78) | 38.55 (6.25) | 24.50 | 43.50 | 1.08 | 0.39 |
| $T_2$ | Oxyfluorfen 23.5% EC, 175 g.a.i/ha (PE) and hand weeding at 45 DAP | 50.00 (7.10) | 25.33 (5.08) | 35.01 | 41.21 | 1.54 | 0.45 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $T_3$ | Pendimethalin 580 g.a.i/ha (PE) and Pendimethalin 580 g.a.i/ha (PoE) | 39.67 (6.31) | 20.33 (4.54) | 51.28 | 38.49 | 1.78 | 0.70 |
| $T_4$ | Pendimethalin 580 g.a.i/ha (PE) 580 and hand weeding at 45 DAP. | 17.37 (4.23) | 8.67 (3.03) | 77.78 | 10.08 | 4.87 | 7.22 |
| $T_5$ | Propaquizafop 5% 43.75 g.a.i/ha + Oxyfluorfen 12% ww/EC 175 g.a.i/ha (PE) and Propaquizafop 5% 43.75 g.a.i/ha + Oxyfluorfen 12% ww/EC 175 g.a.i/ha (PoE) | 20.00 (4.49) | 10.67 (3.32) | 64.20 | 28.38 | 2.15 | 1.04 |
| $T_6$ | Propaquizafop 5% 55.75 g.a.i/ha + Oxyfluorfen 12% ww/EC (PE) and Propaquizafop 5% 55.75 g.a.i/ha + Oxyfluorfen 12% ww/EC (PoE) | 19.29 (4.44) | 10.01 (3.23) | 70.37 | 17.93 | 2.98 | 1.18 |
| $T_7$ | Propaquizafop 5% 43.75 g.a.i/ha + Oxyfluorfen 12% ww/EC 175 g.a.i/ha (PE) and hand weeding at 45 DAP | 18.37 (4.34) | 9.00 (3.07) | 72.36 | 17.33 | 4.81 | 1.21 |
| $T_8$ | Propaquizafop 5% 55.75 g.a.i/ha + Oxyfluorfen 12% ww/EC (PE) and hand weeding at 45 DAP | 26.33 (5.18) | 13.67 (3.76) | 54.32 | 34.96 | 2.03 | 0.88 |
| $T_9$ | Control (Weedy Check). | 127.00 (11.27) | 63.63 (8.01) | 0.00 | 57.22 | 0.00 | 0.00 |
| $T_{10}$ | Weed free (Check). | 0.00 (0.71) | 0.00 (0.71) | 100.00 | 0.00 | 0.00 | 0.00 |
| | S.Em. ± | 2.70 (0.21) | 1.50 (0.16) | 2.80 | 3.60 | 0.70 | 0.80 |
| | CD at 5 % | 8.20 (0.63) | 4.40 (0.50) | 8.30 | 10.60 | 2.00 | 2.40 |

**Table 3 :** Economics of different weed control treatments in garlic

| Sr. No. | Treatments | Total yield (q/ha) | Marketable Yield (q/ha) | Cost of cultivation (Rs) | Gross monetary Returns (Rs) | Net monetary returns (Rs) | B:C ratio |
|---|---|---|---|---|---|---|---|
| $T_1$ | Oxyfluorfen 23.5% EC, 175 g a.i/ha (PE) and Oxyfluorfen 23.5% EC, 175 g a.i/ha (PoE) | 108.09 | 101.33 | 184914 | 303990 | 119076 | 1.64 |
| $T_2$ | Oxyfluorfen 23.5% EC, 175 g.a.i/ha (PE) and hand weeding at 45 DAP | 112.51 | 105.33 | 189952 | 315990 | 126038 | 1.66 |
| $T_3$ | Pendimethalin 580 g.a.i/ha (PE) and Pendimethalin 580 g.a.i/ha (PoE) | 118.08 | 110.00 | 184418 | 330000 | 145582 | 1.78 |
| $T_4$ | Pendimethalin 580 g.a.i/ha (PE) 580 and hand weeding at 45 DAP. | 172.24 | 164.33 | 189708 | 492990 | 303282 | 2.59 |
| $T_5$ | Propaquizafop 5% 43.75 g.a.i/ha + Oxyfluorfen 12% ww/EC 175 g.a.i/ha (PE) and Propaquizafop 5% 43.75 g.a.i/ha + Oxyfluorfen 12% ww/EC 175 g.a.i/ha (PoE) | 137.22 | 128.00 | 184516 | 384000 | 199484 | 2.08 |
| $T_6$ | Propaquizafop 5% 55.75 g.a.i/ha + Oxyfluorfen 12% ww/EC (PE) and Propaquizafop 5% 55.75 g.a.i/ha + Oxyfluorfen 12% ww/EC (PoE) | 157.35 | 149.33 | 185090 | 447990 | 262900 | 2.42 |
| $T_7$ | Propaquizafop 5% 43.75 g.a.i/ha + Oxyfluorfen 12% ww/EC 175 g.a.i/ha (PE) and hand weeding at 45 DAP | 158.18 | 151.33 | 190516 | 453990 | 263474 | 2.38 |
| $T_8$ | Propaquizafop 5% 55.75 g.a.i/ha + Oxyfluorfen 12% ww/EC (PE) and hand weeding at 45 DAP | 124.82 | 115.67 | 190790 | 345990 | 155200 | 1.81 |
| $T_9$ | Control (Weedy Check). | 83.11 | 75.33 | 182990 | 225990 | 43000 | 1.23 |
| $T_{10}$ | Weed free (Check). | 191.49 | 184.33 | 197990 | 552990 | 355000 | 2.79 |

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