Impact of new herbicides on weedpopulation and weed controlefficiency in scented and hybrid rice(*Oryzasativa* L.)

ABSTRACT

Field experiments were carried out to study the effect of herbicide and micronutrient spray on different verities of rice (*Oryza sativa* L.) at Students' Instructional farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.), during *Kharif* season 2022 and 2023. The experiment was laid out in split-split plot design with three replications and 24 treatment combinations comprising of two varieties *viz.*Arize 6444 Gold (V_1) and PB 1509 (V_2)were kept in main plots and three herbicidal treatments*viz.* Control(W_1), Bispyribac-sodium10% SC@ 20 g a.i. ha^{-1} at 25 DAT(W_2), Triafamone 20% + Ethoxysulfuron 10 WG @ 225g ha^{-1} at 25 DAT(W_3) were kept in Sub plots and four micronutrients application*viz*, Zinc Sulphate 0.5% + Ferrous Sulphate 1% foliar spray at 45 and 60 DAT(M_1), Zinc Sulphate 0.5% + Ferrous Sulphate 1% + Manganese Sulphate 0.1% foliar spray at 45 and 60 DAT(M_2), Zinc Sulphate 0.5% + Ferrous Sulphate 1% + Manganese Sulphate 0.1% + Borax 0.2 % foliar spray at 45 and 60 DAT(M_3), Zinc Sulphate 0.5% + Ferrous Sulphate 1% + Manganese Sulphate 0.1% + Borax 0.2 % + Silicon 0.1 % foliar spray at 45 and 60 DAT(M_4) were kept in Sub-sub plots. Result revealed that Arize 6444 Gold variety had better weed suppression compare to PB 1509. On other side, herbicidal application with Triafamone 20% + Ethoxysulfuron 10 WG @ 225g ha^{-1} spray at 25 DAT, provided the most effective control against weed flora, weed fresh weight, dry weight and weed control efficiency, among all the growthstages. However, foliar sprayof Zinc Sulphate 0.5% + Ferrous Sulphate 1% + Manganese Sulphate 0.1% + Borax 0.2 % + Silicon 0.1 % foliar spray at 45 and 60 DAT had a notable impact on reducing dry weed weight and significant influenced on weed control efficiency.

Keywords:*Foliar spray, Herbicide, Micronutrient, Rice, Weed control efficiency, Weeds*

1.Introduction

Rice (*Oryza sativa* L.) is a globally important cereal crop, particularly known for its wider adaptability in wet and submerged growing conditions. As a member of the Poaceae family, rice serves as a staple food for over 60% of the global population, making it a cornerstone of agricultural economies worldwide. The global cultivation area of rice approximately 165.21 million hectares, with an annual production of 509.26 million tonnes and an average productivity of 4600 kg per hectare during the 2020-21 period [10]. In India, it covering 46.38 million hectares

and producing 130.29 million tonnes of grain, with an average productivity of 2809 kg ha^{-1}[1]. Rice primarily consumed by humans, playing a critical role in global food security. It serves as the main source of energy for a significant portion of the world's population, particularly in Asia. The grain is highly caloric, consisting predominantly of 75% starch, which makes it an efficient energy source. It also contains 6-7% protein, 2-2.5% fat, 0.8% cellulose and 5-9% ash, making it a valuable component of a balanced diet [9]**.** Aromatic rice varieties, known for their distinct flavours and consumer appeal, play an important role in global agriculture. The key compound responsible for their unique 'popcorn-like' aroma is 2-acetyl-1-pyrroline (2-AP), identified as the main flavour component [11].Despite its significance, rice cultivation faces challenges, particularly from weeds, which compete for essential resources and can host pests and diseases. Herbicides like Bispyribac-sodium and Council (Triafamone 20% + Ethoxysulfuron 10 WG) have proven effective in controlling weeds, enhancing rice crop yield and quality. In addition, micronutrients such as iron, zinc, manganese, silicon and boron are vital for the healthy growth and development of rice plants, contributing to chlorophyll synthesis, protein production, disease resistance and pollen viability. This study focuses on understanding the combined effects of herbicides and micronutrient application on transplanted rice. By investigating their impact on growth, yield and quality, the research aims to provide valuable insights for optimizing agronomic practices, ultimately improving rice productivity and contributing to global food security.

2.0 Material and Methods

A field experiment was conducted at Students' Instructional farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.). It is situated at an elevation of 125.9 m above the mean sea level $26^0$41'48" North latitude and $80^0$23'21" East longitude. It is situated in the alluvial belt of Indo-Gangetic Plain in the Central part of Uttar Pradesh.Geographically, this experimental site falls under semi-arid with hot summer, moderate rainfall and cold winter. The average annual precipitation of the area varies from 800 to 900 mm with a mean annual precipitation of about 868 mm, mainly through south-west monsoon rains confined within June to last week of September with occasional frost and shower in winter season from North-East monsoon during December and January.The weekly mean minimum and maximum temperature during the entire crop season ranged from 9.90 to 11.40 °C and 43.90 to 42.20 °C, total rainfall received was 836.20 mm and 747.80 mm. The experimental soil was sandy loam in texture with sand 63.24%, clay 13.08% and 23.68% silt, a bulk density of 1.34 g cm^{-3} (0-15 cm), pH of 7.64, electrical conductivity of 0.45 dSm^{-1}, organic carbon at 0.49%, low in available nitrogen (221.41 kg ha^{-1}), available Zinc (0.70 ppm) and medium in Phosphorus (13.04 kg ha^{-1}), potassium (214.84 kg ha^{-1}) and available Fe (6.74 ppm).The Experiment consisted of 24 treatment combinations comprising of two varieties *viz.*Aromatic rice Arize 6444 Gold (V_1) and PB 1509 (V_2) were kept in main plots and three herbicidal treatments*viz.* Control(W_1), Bispyribac-sodium10% SC@ 20 g a.i. ha^{-1} at 25 DAT(W_2), Triafamone 20% + Ethoxysulfuron 10 WG @ 225g ha^{-1} at 25 DAT(W_3) were kept in Sub plots and four micronutrients applications*viz*, Zinc Sulphate 0.5% + Ferrous Sulphate 1% foliar spray at 45 and 60 DAT(M_1), Zinc Sulphate 0.5% + Ferrous Sulphate 1% + Manganese Sulphate 0.1% foliar spray at 45 and 60 DAT(M_2), Zinc

Sulphate 0.5% + Ferrous Sulphate 1% + Manganese Sulphate 0.1% + Borax 0.2 % foliar spray at 45 and 60 DAT(M_3), Zinc Sulphate 0.5% + Ferrous Sulphate 1% + Manganese Sulphate 0.1% + Borax 0.2 % + Silicon 0.1 % foliar spray at 45 and 60 DAT(M_4). The treatments were arranged in a split-split plot design with three replications and plot size 4m width and 5m length. A common procedure was followed in raising seedlings (seed rate- 15 and 45 kg ha^{-1} for hybrid and Basmati, respectively) in the seedbed then uprooting of rice Healthy seedlings, around 25 days old and carefully transplant seedlings into the main field at a spacing of 20x10 cm as row to row and plant to plant using 2-3 seedlings per hill in well prepared puddle field. Weed management by herbicide was spray as post-emergence at 25 DAT with the help of a knapsack sprayer attached with flat fan nozzle using 600 Litters of water per ha. The plot wise crop was harvested by hand with sickles at the time when upper portion of spikelet's looked straw colored and grain has hard, containing 15-18% moisture and left for three days for sun drying then threshing was done manually with the assistance of sticks.All the application fertilizers were done separately in each plot as per treatments. Application of recommended dose of fertilizer, half dose of nitrogen and a full dose of phosphorus and potash were given as basal dose and remaining nitrogen applied as a top dressing in two equal splitsand micronutrient are applied by foliar spray as per treatments.Observed parameters liketotal number of weed flora (m^{-2})at 45, 60 and 90 DAT. From each plot at three places randomly using a quadrate of 50cm x 50cm (0.25 m^2) and multiplied by four to convert into m^{-2}. Weed fresh weight and weed dry weight (g m^{-2}). Weed sample taken from each plot, for the observation of fresh and dry weight of weed was recorded at 30, 60 days after transplanting and at harvest stage. Three plants were uprooted from boarder effect row of each plot and weight of them just after cleaning soil from roots by the help of electric balance for fresh weightand Weed dry weight of weed was recorded by weight was divided by 3 to find the weight of per plant in grams and after sun drying, samples were dried in an oven at 70 ± 1^0c for48 hrs or till constant and weighed. it was expressed in g m^{-2}.

Weed Control Efficiency is a percentage that measures how much a weed control treatment reduces the number of weeds. It's calculated by comparing the number of weeds in a treated plot to the amount in an untreated plot.

$$\mathbf{WCE} = \frac{\boldsymbol{Weed\ dry\ weight\ of\ cotrol\ plot - Weed\ dry\ weight\ of\ treated\ plot}}{\boldsymbol{Weed\ dry\ weight\ of\ cotrol\ plot}} \times \mathbf{100}$$

The collected data on various aspects of weeds during two years of experimentation Data obtained for statistical analysis of variance difference among mean of different treatments. The treatments means were compared using the Least Significant Differences test at 5% level of probability by using the Split-split Plot Design procedure as given by Fisher and Yates (1949). The data on population of individual weed species and their dry matter and spike deformities were analyzed after square root transformation ($X= \sqrt{x+0.5}$). The treatment comparisons were made at 5 % level of significance.

3.0 Result and discussion: -

3.1 Effect on weed population(m^{-2}):

The effect of micronutrients and herbicide application on weed density, weed fresh and dry weight (species wise and total) and weed control efficiency in different rice variety. The major weeds *Echinochloacolona* L., *Echinochloacrusgally* L., *Cyperus rotundus* L., *Commenlina bengalensis* L., *Leptochloa chinensis* L., (m^{-2}) and other weeds (*Phyllanthus niruri* L., *Eleusin indica* L., *Digitairia ciliaris* L., *Cynodondactylon*and *Sorghum helipense* L., etc) were found in rice crop.

3.1.1Effect of rice variety on weed population(m^{-2}):

The population of total weeds(m^{-2})depicted in (Fig. 1,2 and 3) and texted on pooled basis from both the year 2022 and 2023. The minimum population of total weeds(7.52 (57.02), 7.15 (51.64) and 6.07 (37.42) m^{-2} at 45, 60 and 90 DAT, respectively) were recorded in Arize 6444 gold variety and maximum population of total weeds(7.87 (62.50), 7.49 (56.59) and 6.36 (40.96) m^{-2} at 45, 60 and 90 DAT, respectively) were recorded in PB 1509 variety of rice.This reduction may be attributed to the competitive growth characteristics of Arise 6444 Gold, which effectively suppresses weed establishment and growth [6].

3.1.2Effect of herbicidal treatmentson weed population(m^{-2}):

Among both the herbicidal treatments the application of Triafamone 20% + Ethoxysulfuron 10 WG @ 225g ha^{-1} at 25 DAT were recorded minimum weed population (6.08 (37.49), 5.50 (30.75) and 4.39 (19.76) m^{-2} at 45, 60 and 90 DAT, respectively) which was followed by Bispyribac-sodium10% SC@ 20 g a.i. ha^{-1}. The maximum weed population (10.17 (103.91), 10.37 (107.93) and 9.41 (88.95) m^{-2} at 45, 60 and 90 DAT, respectively) were recorded with control plot.TTriafamone 20% + Ethoxysulfuron 10 WG @ 225g $ha^{-1}$is an effective herbicide combination that significantly reduced the fresh weight of broadleaf weeds and sedges in rice crops [3].

3.1.3Effect of micronutrients on weed population(m^{-2}):

Significantly lowest weed population (7.58 (58.02), 7.21 (52.52) and 6.13 (38.05) m^{-2} at 45, 60 and 90 DAT, respectively) were recorded with the foliar spray of Zinc Sulphate 0.5% + Ferrous Sulphate 1% at 45 and 60 DAT which was followed by Zinc Sulphate 0.5% + Ferrous Sulphate 1% + Manganese Sulphate 0.1% at 45 and 60 DAT. However, the maximum weed population (7.91 (63.10), 7.53 (57.13) and 6.39 (41.36) m^{-2} at 45, 60 and 90 DAT, respectively) were recorded with foliar spray of Zinc Sulphate 0.5% + Ferrous Sulphate 1% + Manganese Sulphate 0.1% + Borax 0.2% at 45 and 60 DAT. Lower weed density in hybrid rice with micronutrient application occurs because micronutrients enhanced the crop's growth, vigour, and competitiveness, allowing rice to better outcompete weeds for resources like light, water and nutrients [5].

3.2Effect on fresh weight weeds (g m^{-2}):

3.2.1Effect of rice variety onfresh weight of weeds (g m^{-2}):

The fresh weight of weeds(g m^{-2})represented through graph in fig. (1,2 and 3)and texted on pooled basis from both the year 2022 and 2023. The minimum fresh weight of weeds(8.33 (69.96), 8.29 (69.26) and 6.66 (44.90) g m^{-2} at 45, 60 and 90 DAT, respectively) was recorded in Arize 6444 gold variety.While, maximum fresh weight of total weeds(8.69 (75.95), 8.68 (75.94) and 6.98 (49.18) g m^{-2} at 45,60 and 90 DAT, respectively) was recorded in PB 1509 variety of rice [2].

3.2.2Effect of herbicidal applicationon fresh weight of weeds (g m^{-2}):

Among both the herbicidal treatments the application of Triafamone 20% + Ethoxysulfuron 10 WG @ 225g ha^{-1} at 25 DAT recorded minimum fresh weight of weeds(5.93 (35.71), 5.91 (35.43) and 4.51 (20.81) g m^{-2} at 45, 60 and 90 DAT, respectively) which was followed by Bispyribac-sodium10% SC@ 20 g a.i. ha^{-1} (6.48 (42.44), 6.44 (41.91) and 5.27 (28.24) g m^{-2} at 45, 60 and 90 DAT, respectively). On the contrary, the maximum fresh weight of weeds(13.12 (172.63), 13.12 (172.68) and 10.69 (114.69) g m^{-2} at 45, 60 and 90 DAT, respectively) was recorded with control plot [8].

3.2.3Effect of micronutrients onfresh weight of weeds (g m^{-2}):

Significantly lowest fresh weight of weeds(8.40 (71.04), 8.37 (70.62) and 6.73 (45.77) g m^{-2} at 45, 60 and 90 DAT, respectively) was recorded with the foliar spray of Zinc Sulphate 0.5% + Ferrous Sulphate 1% at 45 and 60 DAT.While, the maximum fresh weight of total weeds(8.71 (76.35), 8.70 (76.15) and 6.99 (49.33) g m^{-2} at 45, 60 and 90 DAT, respectively) was recorded with foliar spray of Zinc Sulphate 0.5% + Ferrous Sulphate 1% + Manganese Sulphate 0.1% + Borax 0.2% at 45 and 60 DAT [7].

3.3 Effect on dry weight of weeds (g m^{-2}):

3.3.1Effect of rice variety on dry weight of weeds (g m^{-2}):

The dry weight of total weeds(g m^{-2})demonstrated in fig. (1, 2 and 3)and texted on pooled basis from both the year 2022 and 2023. The minimum dry weight of weeds(4.60 (21.63), 4.63 (21.97) and 4.18 (17.99) g m^{-2} at 45, 60 and 90 DAT, respectively) was recorded in Arize 6444 gold variety. However, the maximum dry weight of weeds(4.79 (23.40), 4.85 (23.98) and 4.37 (19.61) g m^{-2} at 45, 60 and 90 DAT, respectively) was recorded in PB 1509 variety of rice[4].

3.3.2Effect of herbicidal applicationon dry weight of weeds (g m^{-2}):

Among both the herbicidal treatments the application of Triafamone 20% + Ethoxysulfuron 10 WG @ 225g ha^{-1} at 25 DAT was recorded minimum dry weight of weeds(3.32 (11.52), 3.35 (11.70) and 2.88 (8.80) g m^{-2} at 45, 60 and 90 DAT, respectively) which was followed by Bispyribac-sodium10% SC@ 20 g a.i. ha^{-1} (3.60 (13.49), 3.63 (13.66) and 3.33 (11.62) g m^{-2} at 45, 60 and 90 DAT, respectively). Contrary, the maximum dry weight of weeds(7.15 (51.61), 7.24 (52.98) and 6.62 (44.30) g m^{-2} at 45, 60 and 90 DAT, respectively) was recorded with control plot[6].

3.3.3Effect of micronutrients ondry weight weeds (g m^{-2}):

The effect of adding more micronutrients, such as borax and silicon, showed a reduction in dry weed weights across the intervals. Significantly lowest dry weight of weeds(4.63 (21.96), 4.68 (22.37) and 4.22 (18.33) g m^{-2} at 45, 60 and 90 DAT, respectively) was recorded with the foliar spray of Zinc Sulphate 0.5% + Ferrous Sulphate 1% at 45 and 60 DAT which was followed by Zinc Sulphate 0.5% + Ferrous Sulphate 1% + Manganese Sulphate 0.1% at 45 and 60 DAT (4.63 (22.01), 4.69 (22.45) and 4.23 (18.38) g m^{-2} at 45, 60 and 90 DAT, respectively). While, the maximum dry weight of weeds(4.80 (23.51), 4.85 (24.05) and 4.38 (19.68) g m^{-2} at 45, 60 and 90 DAT, respectively) was recorded with foliar spray of Zinc Sulphate 0.5% + Ferrous Sulphate 1% + Manganese Sulphate 0.1% + Borax 0.2% at 45 and 60 DAT [8].

3.4 Effect on weed control efficiency (WCE):

3.4.1Effect of rice variety onweed control efficiency (WCE):

The data on weed control efficiency are represented through graph in fig. (1,2 and 3)and texted on pooled basis from both the year 2022 and 2023 experimentation. The maximum weed control efficiency (54.98, 55.20 and 54.54 % at 45, 60 and 90 DAT, respectively) was recorded in Arize 6444 gold variety however, the minimum weed control efficiency (53.62, 53.89 and 53.15 % at 45, 60 and 90 DAT, respectively) was recorded in PB 1509 variety of rice. Weed Control Efficiency (WCE) was higher in the variety Arize 6444 gold, across all the growth stage compared to PB 1509[5].

3.4.2Effect of herbicides onweed control efficiency (WCE):

significantly better weed control efficiency were recorded with Triafamone + Ethoxysulfuron10 WG @ 225g ha^{-1} at 25 DAT(83.86, 84.71 and 83.86 % at 45, 60 and 90 DAT, respectively). While, the minimum weed control efficiency (79.08, 78.93 and 77.67 % at 45, 60 and 90 DAT, respectively) was recorded with the application of Bispyribac-sodium10% SC@ 20 g a.i.ha^{-1}at25DAT[3].

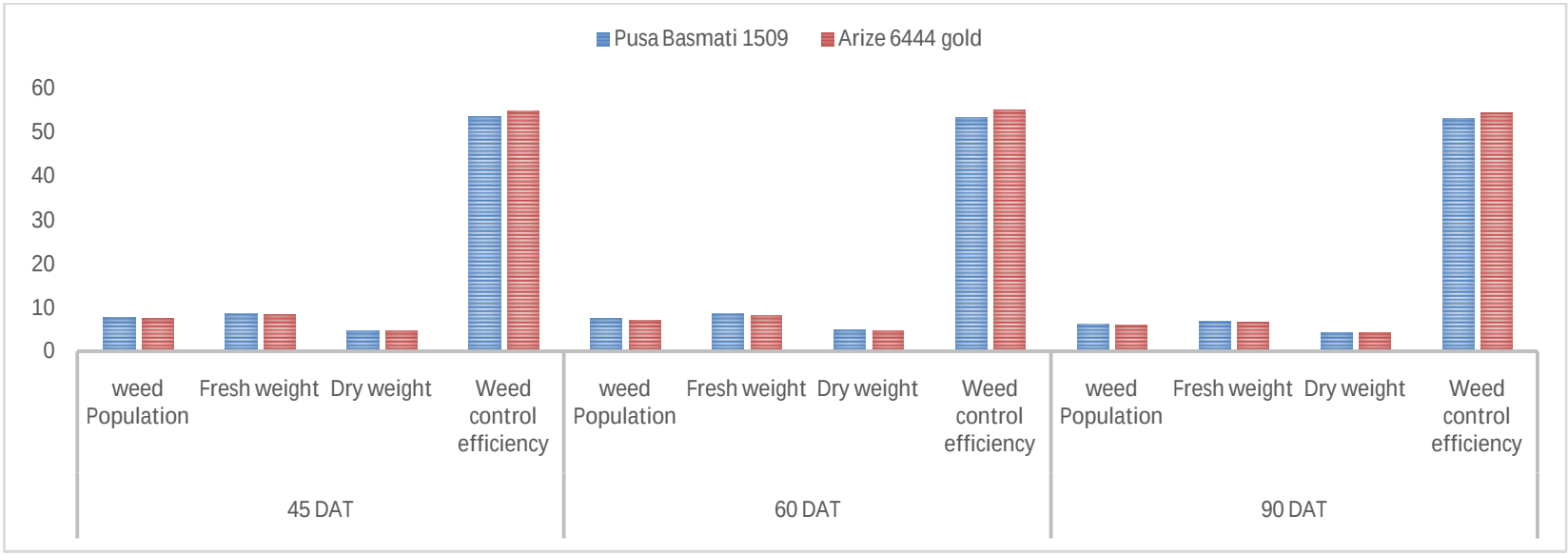

Fig.1- Effect of herbicidal treatments on varieties

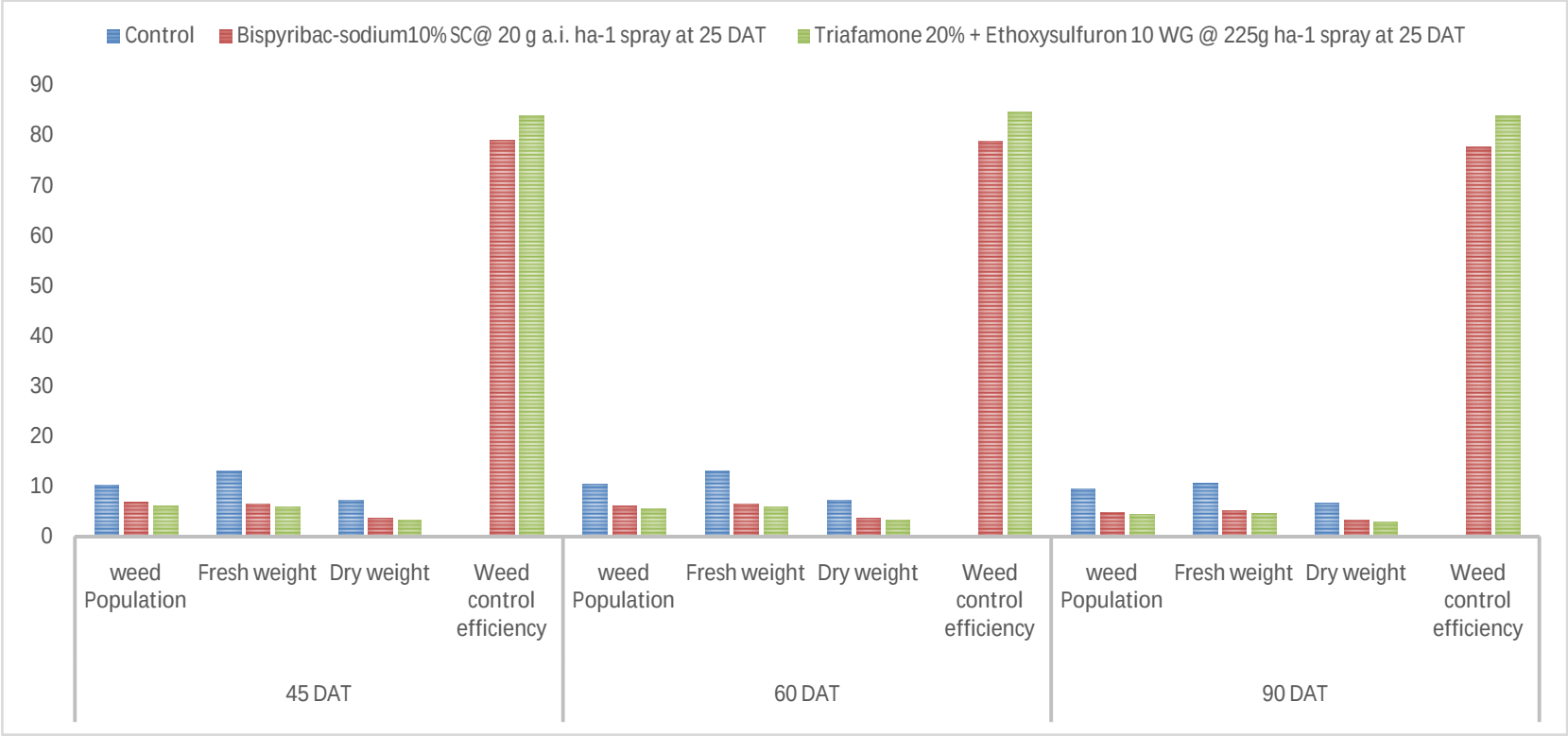

Fig 2Effect of herbicidal treatments on weed management

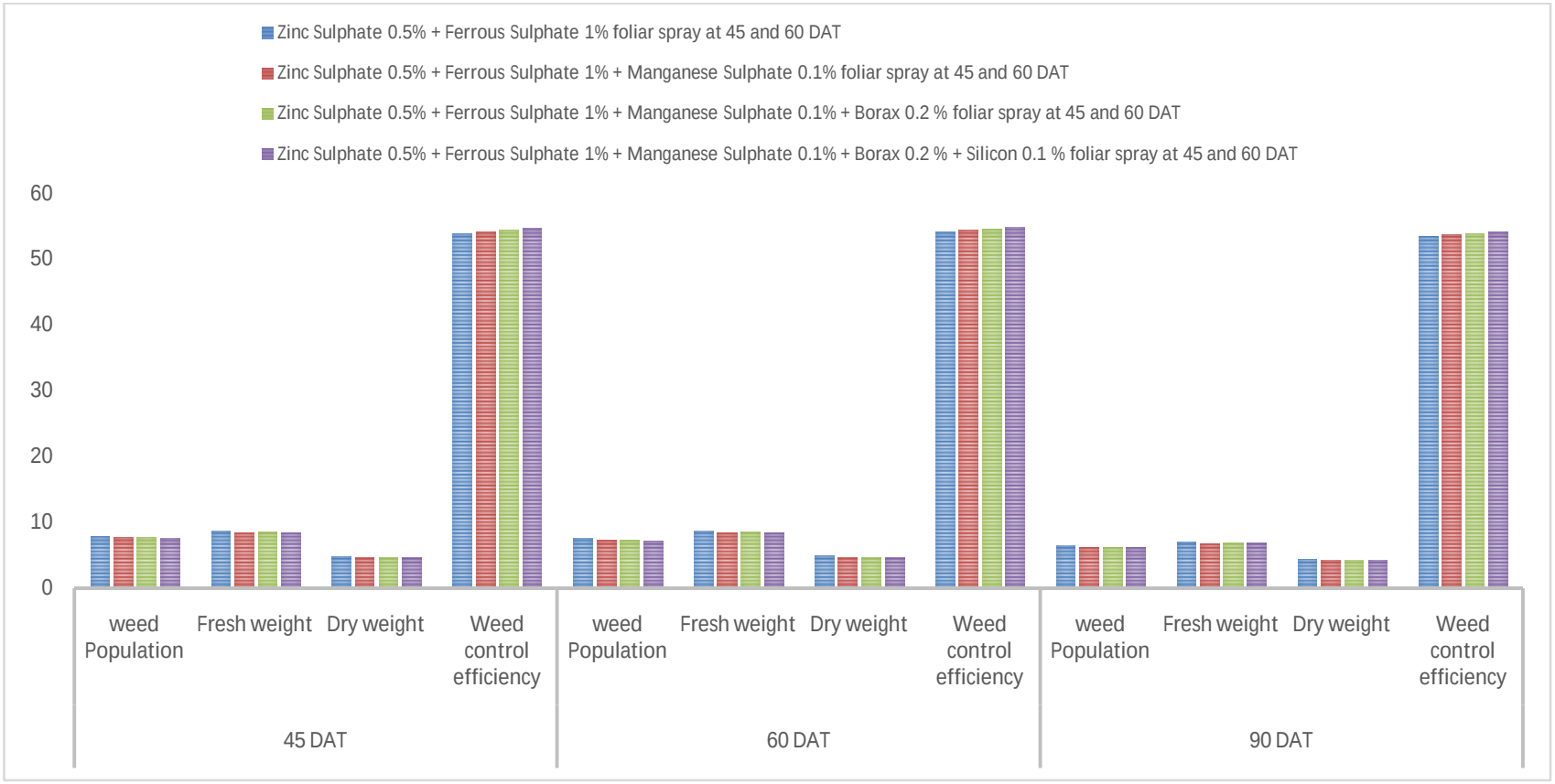

Fig. 3 Effect of micronutrients on weed management

3.4.3Effect of micronutrients onweed control efficiency (WCE):

The highest WCE was observed with the spray of Zinc Sulphate 0.5% + Ferrous Sulphate 1% + Manganese Sulphate 0.1% + Borax 0.2% at 45 and 60 DAT at different growth (54.70% at 45 DAT, 54.91% at 60 DAT, and 54.23% at 90 DAT). While, the lowest WCE was noted with the foliar spray ofZinc Sulphate 0.5% + Ferrous Sulphate 1% + Manganese Sulphate 0.1% + Borax 0.2% + Silicon 0.1% at 45 and 60 DAT, but differences among treatments were not statistically significant as the value shows no significance (NS) at different growth stage.

Conclusion:

Therefore,assess the"Effect of herbicides and micronutrients spray on different varities of rice (*Oryza sativa* L.)"on weeds flora, weed fresh weight, dry weight and weed control efficiency. There are three major conclusions can be drawn from research.Firstly, the effect of variety Arize 6444 Gold had better weed suppression ability compared to PB 1509. Secondly, weed management treatment with Triafamone 20% + Ethoxysulfuron 10 WG @ 225g ha^{-1} spray at 25 DAT, provided the most effective control of weed flora, weed fresh weight, dry weight and weed control efficiency, across all the stages of growth. Thirdly, among micronutrient treatments, the application of Zinc Sulphate 0.5% + Ferrous Sulphate 1% + Manganese Sulphate 0.1% + Borax 0.2 % + Silicon 0.1 % foliar spray at 45 and 60 DAT had a notable impact on reducing dry weed weight and significantly influenced onweed control efficiency.

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1.

2.

3.

Author contribution:

Jaykar Singh has designed, Conceived and performed the field experiment and wrote the original draft.reviewed and edited the paper. All authors have read and agreed to the published version of the manuscript.

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