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Influence of different sources of fertilizers and weed control treatments on growth, phenology, and yield of baby corn (*Zea mays* L.) in semi-arid of India

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ABSTRACT

The field research work was conducted at the teaching and research farm, Department of Agronomy lovely professional university, Punjab during 2021 *Kharif* season. The research aimed to determine the best fertilizer combination and weed control method for increasing baby corn production. The growth and phenological attributes such as leaf area, leaf area index, days to 50% tasselling, silking, and yield attributes such as cob length, weight, and yield (unhusked) were higher in the application of poultry dropping 1.55 t/ha + 125% RDN in comparison with the remaining treatments. In weed control methods, significantly lower dry weight of weed and maximum weed control efficiency were observed in the post-emergence application of tembotrione 100 mL/ha compared to the weedy check. In addition to these, highest mean values for growth and phenological attributes such as leaf area, leaf area index, days to 50% tasselling, silking, and yield attributes such as cob length, cob weight, and unhusked cob yield per hectare were also recorded in the post-emergence application of Tembotrione 100 mL/ha. The study concludes that poultry manure at 1.55 t/ha + 125% RDN and post-emergence application of tembotrione at 100 mL/ha are most effective for weed control and better yield of baby corn.

1. INTRODUCTION

Baby corn is a vegetable picked from regular maize or sweet corn plants when the ears are still premature and immediately after the emergence of white silk (2–3 cm) length. It is a short season maize variety that can be grown throughout the year. It is highly adapted to a wide range of vegetation and is among the most important maize varieties grown for diet for humans and feed for animals. Besides a higher plant population density, detasseling, and an early harvest, baby corn production is comparable to standard grain maize cultivation. The crop requires well-drained and sandy loam to silty loam soils for optimum growth and development. The crop potential economy increases when harvested earlier because it provides green, soft, succulent, nourishing, palatable, and more easily digestible fodder. The cobs from a baby corn crop take about 60–65 days to mature, and the rest of the plant can be utilized as green fodder. The young ear is de-husked, eaten raw as a salad, and used to make vegetables, pickles, and soup. The nutritional value of baby corn is similar to that of several vegetables, including cauliflower, cabbage, tomato, and radish. After harvest, the economic potential is increased, because it provides green, soft, and succulent nutritious palatable fodder with higher digestibility [1]. The cultivation of the crop is gaining interest in India with increasing production in the states such as Meghalaya, Haryana, Maharashtra, Karnataka, and Andhra Pradesh. Farmers are becoming more interested in baby production due to its low production costs, high domestic demand, promising market, potential value addition, support for the domestic economy, and higher revenue [2]. Despite the low cost of production and high yield potential of this crop, the yield in the farmer's field is relatively low. Due to numerous factors such drought, pests, diseases, weeds infestation, and soil fertility problems, among others, weeds and fertility problems become a serious threat to crop productivity. Weed is among the factors that pose a serious menace to crop production. It hinders crop growth by competing with the crop for nutrients, solar radiation, moisture, and carbon dioxide, reducing baby corn yield and interfering with normal crop growth.

According to Larbi *et al.,* [3] weed interference causes crop losses. It increases insect pest damage, harvesting problems, crop contamination, and production costs. Manual weeding is the most popular weed control method among peasant farmers in India; it is tedious, slow and ineffective, and sometimes costly. Thus, the use of selective herbicides on baby corn, such as atrazine, pendimethalin, and tembotrione or their combinations, is necessary for better crop productivity. Chemical fertilizers to restore soil fertility are costly and in short supply. Furthermore, quantity requirement and cost of transportation of organic manure are serious concerns resulting in the application of alternatives such as poultry manure and nitrogen

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fertilizers in combination to improve soil nutrients balance and reduce the detrimental effect of the long-term use of chemical fertilizers. Therefore, the use of selective herbicides and applying organic and inorganic fertilizers together ensures a long-term nutrient balance in the soil, improves soil aggregation, and boosts moisture retention and fertility. These two factors contribute considerably to the low yield of baby corn obtained in India, but they can all be managed.

2. MATERIALS AND METHODS

2.1. Experimental Site and Design

This research work was carried out at the lovely professional university teaching and research farm Punjab during the 2021 Kharif season. The experiment was laid out in a split-plot design and replicated 3 times.

2.2. Experimental Treatments

The main plot treatment consisted of four fertilizer treatments, viz-a-viz, (1) poultry dropping applied at 2.5 t/ha, (2) poultry dropping 1.75 t/ha + 75% RDN, (3) poultry dropping 1.75 t/ha + 100% RDN, and (4) poultry dropping 1.5 t/ha + 125% RDN. The five weed control treatments used in the sub-plots were atrazine applied at 800 g/ha, atrazine at 800 g/ha + pendimethalin 100 mL/ha, and tembotrione at 100 mL/ha PoE, live mulch (cowpea), and weedy check.

2.3. Agronomic Practices

The experimental area was harrowed and ridged at intervals of 60 cm. The area was then split up into plots and replications. In addition, there were 1 m between replications and 0.5 m between each of the five plots. Before planting the crop, poultry dropping was spread in split applications within the furrows per treatment basis. The first dose of nitrogen, phosphorus, and potassium was applied before sowing using DAP, SSP, UREA, and MOP. At 20DAS, urea (46% N) was used to supply the remaining N, and seeds were manually sown at a spacing of 60 × 20 cm. When the plants had reached physiological maturity, and the seed had a moisture content of about 20%, the ear was manually harvested. Water canals were built to ensure that water was delivered efficiently to each furrow during irrigation.

2.4. Data Collection

Data on weeds such as weed occurrence weight and weed control efficiency were measured at different sampling periods. Vegetative growth parameters such as leaf area and leaf area index of the crop were determined at 40 DAS and at harvest. Phenological attributes such as days to 50% tasselling and silking were also recorded. Yield and yield components (cobs per plant, weight cobs per plant, cob yield, and harvest index) were assessed after harvest.

2.5. Data Analysis

Data recorded were put through analysis of variance (ANOVA) using STAR (Statistical tool for agriculture) software. Duncan multiple test range was used to separate means that are significant.

3. RESULTS

3.1. Weed Flora

The common and dominant weed species were sedges such as *Cyperus rotundus* and *Cyperus esculentus, Brachiaria deflex*a, *Digitaria horizontalis, Dactyloctenium aegyptium* Linn, and *Cynodon dactylon* (L.) Persand, *Euphorbia hirta, Ageratum conyzoides,* and *Commelina benghalensis*.

3.2. Weed Dry Weight (g/m^2)

The dry weight of weed was significantly responded to fertilizers at all sampling periods. Plots treated with poultry 2.5 t/ha recorded the highest dry weight of weed followed by poultry dropping 1.75/ha + 75% RDN, poultry manure at 1.75 t/ha + 100% RDN, and poultry manure 1.5 t/ha + 125% RDN in that order [Figure 1]. Weed control treatments were significant on weed dry weight. At all sampling stages, the weedy check had the highest mean value for dry weight of weed, followed by plots treated with atrazine 800 g/ha, live mulch and atrazine + pendimethalin (800 g + 100 mL/ha), and post-emergence application of tembotrione (100 mL/ha) in that order [Table 1].

3.3. Weed Control Efficiency

Weed control efficiency was also significant due to application of fertilizer treatment all the sampling periods. Combined application of poultry dropping and recommended dose of nitrogen at different doses recorded the highest weed control efficiency over the poultry dropping alone at 40 DAS and harvest [Figure 2]. In weed control treatments, application of atrazine at 800 g/ha + pendimethalin at 100 mL/ha registered highest weed control efficiency at 40 DAS. At other sampling periods, post-emergence application of tembotrione at 100 mL/ha consistently recorded the highest weed control efficiency and weedy check had the lowest mean value [Table 2].

3.4. Days to 50% Tasselling and Silking

The influence of fertilizer treatments on days to 50% tasselling was significant where application of poultry dropping at 1.55 t/ha + 125% RDN resulted in delayed tasselling while plants in the plots that received 2.5 t/ha of poultry dropping had shorter number of days to

Table 1: Effect of fertilizer source and weed control on weed dry weight of baby corn during 2021 kharif season in semi-arid of India.

Treatment	Weed dry weight (g/m^2)	
	40DAS	Harvest
Nutrition source		
Poultry dropping 2.5 t/ha	114.38^a	109.50^a
Poultry dropping 1.75 t/ha+75% RDN	101.27^b	107.64^a
Poultry dropping 1.75 t/ha+100% RDN	97.73^b	92.84^b
Poultry dropping 1.55 t/ha+125% RDN	95.49^b	92.63^b
SEM (±)	5.286	5.850
CD (0.5%)	13.101	14.593
Weed control		
Atrazine 800 g/ha	99.98^b	105.40^b
Atrazine+pendimethalin (800 g+100 mL/ha)	63.43^c	93.80^b
Tembotrione 100 mL/ha	34.17d	41.61^c
Live mulch (Cowpea)	59.20^c	93.91^b
Weedy check (control)	147.32^a	168.55^a
SEM (±)	NS	6.222
CD (0.5%)	14.515	5.232
Interaction N×W	NS	NS

Means accompanied with the same alphabetical letters within column are statistically similar at (0.5) level. t/ha: Tons per hectare, RDN: Recommended dose of nitrogen, mL/ha: Mil per hectare, SEM: Standard error of mean, CD: Critical difference, N×W: Interaction between fertilizer and weed control, NS: Not significant

Table 2: Effect of fertilizer source and weed control on weed control efficiency of baby corn during 2021 Kharif season in the semi-arid of India.

Treatment	Weed control efficiency (%)	
	40DAS	Harvest
Nutrition source (N)		
Poultry dropping 2.5 t/ha	37.89[c]	34.51[b]
Poultry dropping 1.75 t/ha+75% RDN	39.09[a]	35.21[b]
Poultry dropping 1.75 t/ha+100% RDN	39.87[a]	38.06[b]
Poultry dropping 1.55 t/ha+125% RDN	44.40[a]	47.58[a]
SEM (±)	6.834	7.935
CD (0.5%)	6.712	8.309
Weed control (W)		
Atrazine 800 g/ha	32.61[c]	33.09[b]
Atrazine+pendimethalin (800 g+100 mL/ha)	35.56[c]	40.20[b]
Tembotrione 100 mL/ha	76.30[a]	73.43a
Live mulch (Cowpea)	57.08[b]	38.74[b]
Weedy check (control)	0.00[d]	0.00[c]
SEM (±)	3.486	2.951
CD (0.5%)	6.387	8.540
InteractionN×W	NS	NS

Means accompanied with the same alphabetical letters within column are statistically similar at (0.5) level. t/ha: tons per hectare, RDN: Recommended dose of nitrogen, mL/ha: Mil per hectare, SEM: Standard error of mean, CD: Critical difference, N×W: Interaction between fertilizer and weed control, NS: Not significant

50% tasselling [Figure 3]. Likewise, a similar trend was observed on days to 50% silking. The interaction between the factors was not significant [Table 3].

3.5. Leaf Area and Leaf Area Index

Leaf area and leaf area index were affected by the fertilizer treatments at all the stages of sampling, in which combined application of poultry dropping at 1.55 t/ha + 125% RDN produced the highest leaf area and index accompanied by poultry dropping at 1.75 t/ha + 100% RDN, poultry dropping at 1.75 t/ha + 75% RDN, and the least mean value was recorded in the poultry dropping at 2.5 t/ha [Figure 4]. In weed control treatments, tembotrione applied at 100 mL/ha PoE consistently produced the highest leaf area and index at both sampling stages, while the weedy check produced the least mean value. The interaction between the factors was not significant at both sampling stages [Figure 5].

3.6. Cob Length (cm)

The influence of fertilizer sources on cob length was significant, in which application of poultry manure 1.5 t/ha + 125% RDN recorded the highest value for cob length than poultry manure 1.75 t/ha + 100% RDN, poultry manure 1.75 t/ha + 100% RDN, poultry manure 1.75 t/ha+ 75% RDN, and poultry manure 2.5 t/ha had the least. In weed control treatment the post-emergence application of tembotrione at 100ml/ha recorded the highest mean (cob length) that was comparable with the plots treated with atrazine at 800g/ha + pendimethalin 100Ml/ha but significantly higher than the live mulch and atrazine at 800g/ha. The least value was recorded in the control, that is, weedy check [Table 3]. The interaction between the factors was not significant.

Table 3: Effect of fertilizer source and weed control on number of days to 50% tasselling and silking and cob per plant of baby corn during 2021 Kharif season in the semi-arid of India.

Treatment	Days to 50% tasselling	Days to 50% silking	Cob perplant
Nutrients source (N)			
Poultry dropping 2.5 t/ha	38.00[c]	44.00[b]	2.13[b]
Poultry dropping 1.75 t/ha+75% RDN	44.13[b]	49.00[a]	2.14[b]
Poultry dropping 1.75 t/ha+100% RDN	46.00[b]	50.06[a]	2.94[a]
Poultry dropping 1.55 t/ha+125% RDN	49.86[a]	53.31[a]	3.27[a]
SEM (±)	1.103	0.692	0.173
CD (0.5%)	3.892	4.387	0.611
Weed control (W)			
Atrazine 800 g/ha	44.66[b]	49.50[b]	2.58[c]
Atrazine+pendimethalin (800 g+100 mL/ha)	43.16[b]	49.08[b]	2.67[b]
Tembotrione 100 mL/ha	42.08[b]	47.00[b]	3.58[a]
Live mulch (cowpea)	43.50[b]	47.66[b]	2.67[b]
Weedy check (control)	48.25[a]	54.08[a]	1.56[d]
SEM (±)	1.156	1.435	0.180
CD (0.5%)	3.346	3.441	0.520
Interaction N×W	NS	NS	NS

Means accompanied with the same alphabetical letters within column are statistically similar at (0.5) level. t/ha: Tons per hectare, RDN: Recommended dose of nitrogen, mL/ha: Mil per hectare, SEM: Standard error of mean, CD: Critical difference, N×W: Interaction between fertilizer and weed control, NS: Not significant

3.7. Cobs Per Plant and Cob Weight (g)

Plot treated poultry manure 1.5 t/ha + 125% RDN registered heavier cobs that were statistically similar with poultry manure 1.75 t/ha + 100% RDN but significantly higher than poultry manure 1.75 t/ha + 75% RDN and poultry manure 2.5 t/ha [Figure 6]. Weed control also affected cob weight, in which post-emergence application of tembotrione 100 mL/ha produced significantly higher value followed by atrazine 800 g/ha + pendimethalin 100 mL/ha that was comparable with live mulch but significantly higher than atrazine 800 g/ha and weedy check. Like-wise a comparable trend was observed in the cobs per plant [Table 4].

3.8. Cob Yield (t/ha)

The effect of fertilizer treatments was significant in baby corn yield, in which poultry manure 1.5 t/ha + 125% RDN recorded the highest cob yield, followed by poultry manure 1.75 t/ha + 100% RDN, 1.75 t/ha + 75% RDN, and poultry manure 2.5 t/ha in that order. Under weed control treatments post-emergence application of tembotrione 100 mL/ha out yielded the other treatments [Table 4].

4. DISCUSSION

4.1. Response of Baby Corn to Fertilizer Source

Growth parameters of baby corn such as leaf area, leaf area index, and phenological parameters such as days to 50% tasselling and silking were positive and significantly influenced by application of difference sources of nutrition. The leaf area and leaf area

Table 4: Effect of fertilizer source and weed control on plant height of baby corn during 2021 Kharif season in the semi-arid of India.

Treatment	Leaf area (cm^2)		Leaf area index	
	40DAS	Harvest	40DAS	Harvest
Nutrition source				
Poultry dropping 2.5 t/ha	219.60^c	236.86^d	1.83^c	1.97^d
Poultry dropping 1.75 t/ha+75% RDN	222.08^c	273.20^c	1.85^c	2.27^c
Poultry dropping 1.75 t/ha+100% RDN	307.57^b	343.56^b	2.56^b	2.86^b
Poultry dropping 1.55 t/ha+125% RDN	358.04^a	386.62^a	2.98^a	3.22^a
SEM (±)	9.809	7.741	0.082	0.101
CD (0.5%)	34.602	22.248	0.288	0.357
Weed control				
Atrazine 800 g/ha	291.76^b	310.37^c	2.43^b	2.58^c
Atrazine+pendimethalin (800g+100 mL/ha)	305.39^b	341.26^b	2.50^b	2.83^b
Tembotrione 100 mL/ha	336.43^a	374.87^a	2.80^a	3.12^a
Live mulch (Cowpea)	309.80^a	322.83^c	2.58^b	2.69^b
Weedy check (control)	162.32^c	178.38^d	1.35^c	1.48^d
SEM (±)	9.373	8.655	0.078	0.061
CD (0.5%)	27.124	24.875	0.226	0.178
Interaction N×W	NS	NS	NS	NS

Means accompanied with the same alphabetical letters within column are statistically similar at (0.5) level. t/ha: Tons per hectare, RDN: Recommended dose of nitrogen, mL/ha: Mil per hectare, SEM: Standard error of mean, CD: Critical difference, N×W: Interaction between fertilizer and weed control, NS: Not significant

index of baby corn in poultry dropping + RDN applied plots were statistically higher than that of poultry dropping alone at 40 DAS and harvest. The highest mean value for leaf area and leaf area index observed in poultry dropping at 1.5 t/ha + 125% RDN treated plots was a result efficient supply of essential plant nutrients by the poultry dropping coupled with the faster release of primary nutrients by the inorganic fertilizer this provided a better interception of radiation which enhances photosynthesis resulting to a better yield of the baby corn. Supporting this finding is [4-6], who reported an increase in growth parameters like plant height, number of leave, and leaf area index of maize due to higher dose of organic and inorganic fertilizers. The significantly lower leaf area and leaf area index recorded in the poultry dropping applied plots were due to the slow release of nutrients by the poultry dropping, which slowed the vegetative growth of the crop. The application of 1.5 t/ha of poultry dropping + 125% RDN delayed days to 50% tasselling and silking of baby corn compared to other fertilizer-treated plots. Delay in attaining tasselling and silking in the poultry dropping + 125% RDN applied plots could be attributed to the sufficient supply of essential nutrients and improvement in the water holding capacity of the soil by organic and inorganic fertilizer sources which could result in moisture and nutrient availability that sustained the baby corn throughout the growing period and promotes vegetative plant growth, more photosynthesis and assimilates production. Similar findings by [7,8] reported that higher vegetative growth in maize due to the slow release of nutrients by organic manure during the growing season resulted in delayed tasselling of maize. Yield components such as cob length, weight, and yield responded positively to fertilizer treatments. The application of poultry

Table 5: Effect of fertilizer source and weed control on cobs per plant, cob weight and length of baby corn during 2021 Kharif season in the semi-arid of India.

Treatment	Cob length (cm)	Cob weight (g)	Cob yield (t/ha)
Nutrients source (N)			
Poultry dropping 2.5 t/ha	7.45^d	7.21^b	1.38^d
Poultry dropping 1.75 t/ha+75% RDN	7.68^c	7.95^b	1.41^c
Poultry dropping 1.75 t/ha+100% RDN	8.00^b	8.04^a	1.48^b
Poultry dropping 1.55 t/ha+125% RDN	8.34^a	8.16^a	1.49^a
SEM (±)	1.625	1.631	0.022
CD (0.5%)	0.552	0.730	0.078
Weed control (W)			
Atrazine 800 g/ha	7.78^c	8.01^c	1.53^d
Atrazine+pendimethalin (800 g+100 mL/ha)	8.12^a	8.72^b	1.61^b
Tembotrione 100 mL/ha	9.10^a	9.10^a	1.78^a
Live mulch (cowpea)	8.11^b	8.31^b	1.60^c
Weedy check (control)	6.19^d	6.43^d	0.68^e
SEM (±)	1.835	1.482	0.032
CD (0.5%)	0.781	1.222	0.094
Interaction N×W	NS	NS	NS

Means accompanied with the same alphabetical letters within column are statistically similar at (0.5) level. t/ha: Tons per hectare, RDN: Recommended dose of nitrogen, mL/ha: Mil per hectare, SEM: Standard error of mean, CD: Critical difference, N×W: Interaction between fertilizer and weed control, NS: Not significant

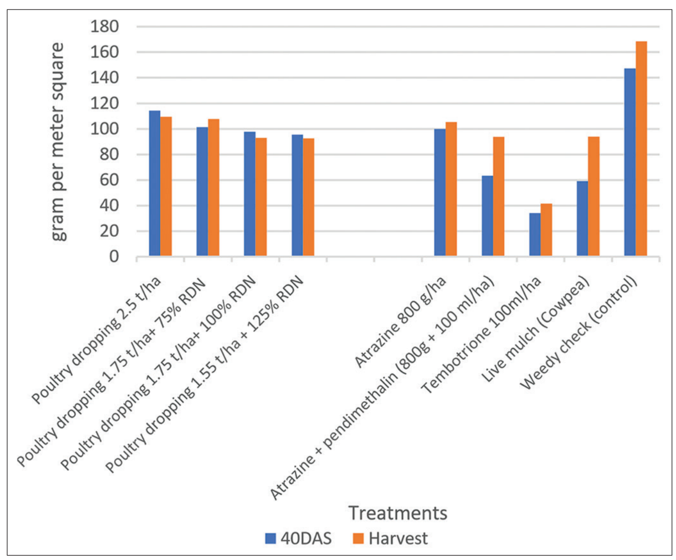

Figure 1: Effect of fertilizer source and weed control on weed dry weight of baby corn during 2021 Kharif season in Punjab.

dropping at 1.5 t/ha + 125% RDN recorded the highest cob length, weight, and yield than the rest of the treatments. This linear increase in the yield attributes with an increase in dose of inorganic fertilizer (RDN %) is possibly due to the fast release of mineral elements that were made readily available and easily taken up by the receiving plants leading to more excellent production of photosynthates and

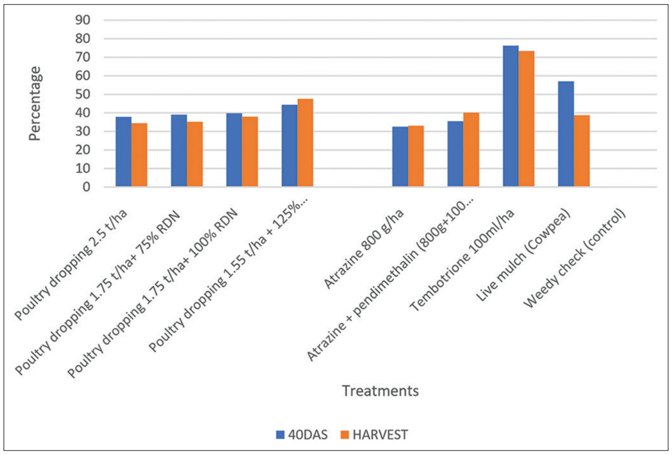

Figure 2: Effect of fertilizer source and weed control on weed control efficiency of baby corn during 2021 Kharif season in Punjab.

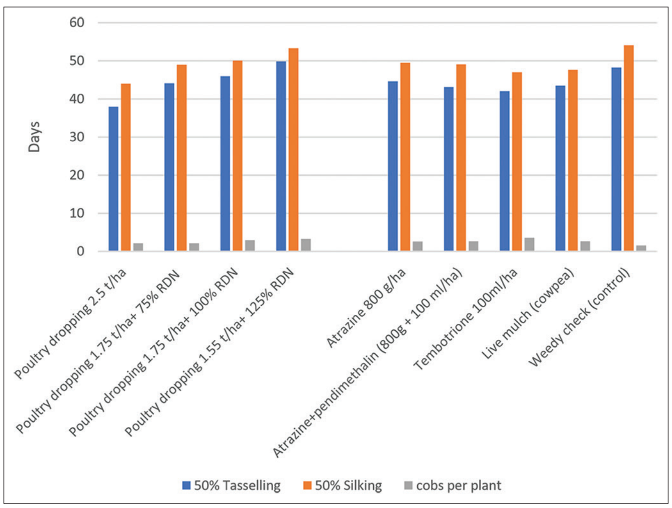

Figure 3: Effect of fertilizer source and weed control on number of days to 50% tasselling and silking and cob per plant of baby corn during 2021 Kharif season in Punjab.

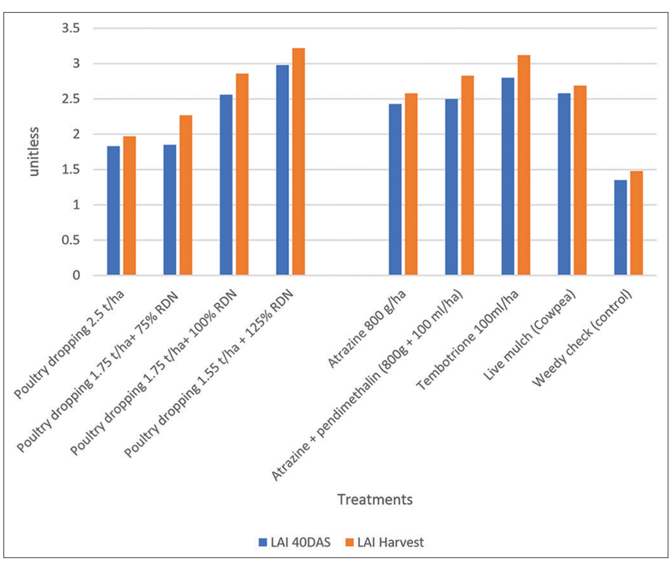

Figure 4: Leaf area index.

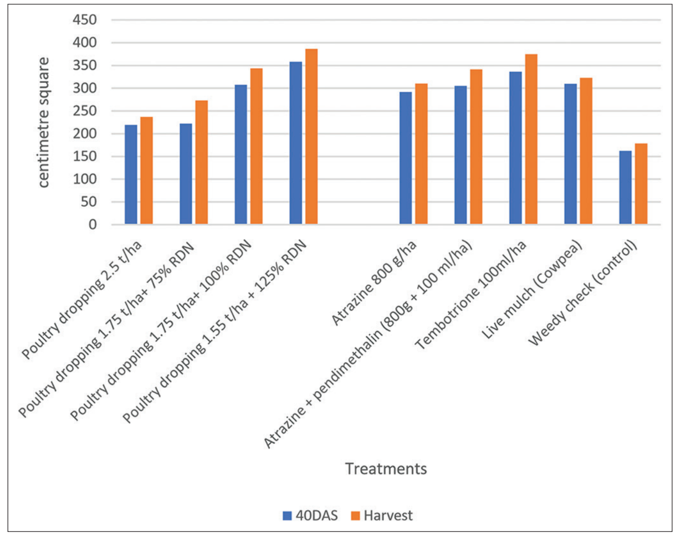

Figure 5: Leaf area.

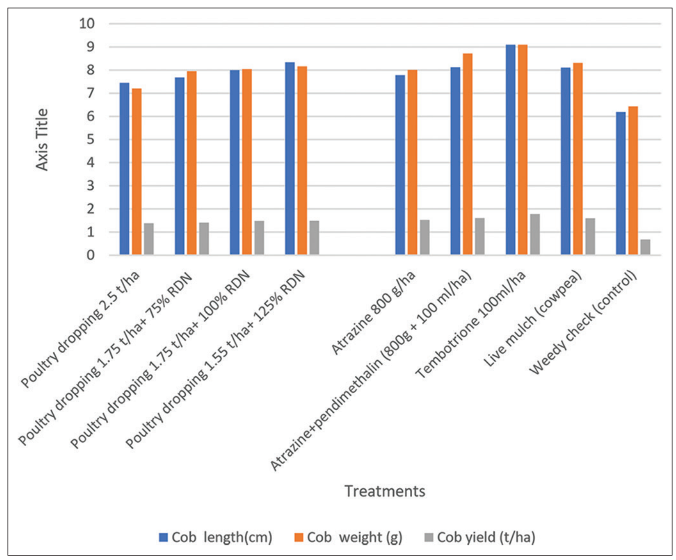

Figure 6: Effect of fertilizer source and weed control on cobs per plant, cob weight and length of baby corn during 2021 Kharif season in Punjab.

their efficient translocation for development of the reproductive parts resulting to higher baby corn yield. The result corroborates with the findings of [9,10] who reported that higher maize yield was obtained from plants that received higher doses of poultry manure and nitrogen fertilizers than the other plants.

4.2. Response of Baby Corn to Weed Control Treatments

The findings of this research indicate that tembotrione applied at 100 mL/ha PoE provided better weed control and produced low dry weight of weed and maximum weed control efficiency than the rest of the treatments. The possible reason can be attributed to effective control of weeds by the tembotrione by exhibiting its herbicidal effect, which resulted in a drastic reduction of weed dry weight and increased weed control efficiency. This finding agrees with [11,12], who observed a significant reduction of dry weight of weed and maximum weed control efficiency in tembotrione applied plots in maize. The significantly higher weed dry matter and low weed control efficiency recorded in the weedy check plots could be due to intense competition for limited resources, which result in a drastic reduction in the performance of the crop. A similar result was reported by [11,13-15]. They attributed this to the intense competition between the weeds and crops for scarce environmental resources. The positive response of baby corn to weed control treatments observed could have been the reason for the improved performance of the crop with regard to leaf area and leaf area index compared with the weedy check. The relatively low leaf area and index observed in the weedy check could be attributed to competition between weeds and crop plants for moisture and nutrients such that plants could not produce more leaves to conserve the available moisture for critical growth stages, which significantly depressed these growth parameters. The tasselling and silking were delayed in the weedy check plots. This may probably be due to serious competition between weeds and crop plants. The crop performance on yield parameters and baby corn yield was higher with all the weed control treatments compared to weedy check. Moreover, this could be attributed to effective weed control in the herbicide treated plots which resulted in maximum nutrient utilization and led to the production of high assimilation of photosynthates, causing an increase in the yield of baby corn. Supporting this finding is [10,13,16-18], who observed an increase in yield attributes of maize in herbicide-treated plots over the weedy check.

5. CONCLUSION

The study concludes that poultry manure at 1.55 t/ha + 125% RDN and post-emergence application of tembotrione at 100 mL/ha is most effective for weed control and better yield of baby corn.

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7. AUTHORS' CONTRIBUTIONS

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agreed to be accountable for all aspects of the work. All the authors are eligible to be an author as per the International Committee of Medical Journal Editors (ICMJE) requirements/guidelines.

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9. CONFLICTS OF INTEREST

The authors report no financial or any other conflicts of interest in this work.

10. ETHICAL APPROVALS

This study does not involve experiments on animals or human subjects.

11. DATA AVAILABILITY

The dataset generated during this study are available from corresponding author on reasonable request.

12. PUBLISHER'S NOTE

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