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MINIMIZING WEED IMPACTS AND YIELD LOSSES BY APPLICATION OF BROAD-SPECTRUM HERBICIDES IN MAIZE IN THE CENTRAL HIGHLAND OF ETHIOPIA

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ABSTRACT

A large quantity of maize is wasted due to weeds in Holeta and Ejere districts of Central Ethiopia. The weeds invade the crop fields during the early growth stage by germinating from the soil and driving nutrients from the soil. To manage the crop from the weeds, farmers exercise cultural weed control methods. However, this method of managing the weeds from the crop is tiresome and inefficient. Hence, it was assumed that application of the crops with herbicides soon after sowing or practicing weed free from emergence up to the time of maturity prevents the weeds. The study was to test the efficacy of herbicides on several weed species and increase maize production. The RCBD with three replications was used with plot dimensions every one calculating 5m x 4m. Plots were treated with AGENT 600 ml ha^{-1}, COYOTE 440 SE $3L.ha^{-1}$, Primagramgold $3L.ha^{-1}$, S-Maspor 960 EC $3L.ha^{-1}$, Surestart $3L.ha^{-1}$ and weedy check. The application of S-Maspor 960 EC reduced the density of *Corrigiola capensis* by 93.3 %, *Plantago lanceoleta* by 51.6%, *Spergula arvensis* by 51.6% in Ejere tested location whereas treating plots with Surestart significantly decreased the remaining weed species in Holeta and Ejere. Furthermore, significantly increased cob length by 4.3%, grain yield by 17.58 folds, and reduced yield loss by 93.3% as compared to weedy check plots were also received from the application of Surestart. It is concluded that the application of Surestart 3L ha^{-1} has proven to significantly decrease weed density and enhanced grain yield.

***Keywords*:** Application, Compared, Decreased, Revealed, Weedy check

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1. INTRODUCTION

Maize farming remained formerly for survival resolves in Ethiopia. It has progressively become a dynamic marketable crop on which several agricultural-associated manufacturing products are contingent as their fresh material (Iken and Amusa 2004; Tafesse et al. 2023). In spite of a great request for maize, here is the opportunity to increase production per unit area. According to the reports of Jones and Thornton (2003), worldwide production means is to be found at 4.3tons/hectare and yield may be increased to 8.6tons/hectare in industrialized states. Even though a harvest possible of between 3 and 8 tons per hectare has been predictable for African soils (Sakala and Kabambe 2004; Kayamo et al. 2023), normal cultivation of maize in Ethiopia is quite below actual yield, going in the middle of 1.3 and 1.5tons/hectare (Khan et al. 2003; Sarkin et al. 2019) and if not in effect inclinations are move back, Ethiopia will be necessary the world's principal net shortage in cereals in the close yet to come (Mwangi 1995).

Noticeably, in the midst of the issues associated with the high alteration between possible and real produces of maize in Ethiopia, there is an occurrence of weeds. Maize is vulnerable to struggles with weeds mainly starting in the first growth stages (Hall et al. 1992). Most growers in Ethiopia sort weed as the chief restraint in their farming schemes. Harvest sufferers in line for weeds reach from 25% to entire harvest loss if weeds are not weeded in between the earlier six weeks (Vissoh et al. 2004). Manual weeding is the main device technique used by smallholder agriculturalists in Africa (Chikoye et al. 2002; Moond et al. 2023). This technique has been brought into being to make loose the soil near the produce root and increase crop progression and harvest (Iremiren 1988). Nevertheless, this way is laborious and increases the price of production. Manual weeding of one hectare of the plot into maize may require as far as 25-40man-days, on behalf of around 50-80% of the entire manual labor budget (Darkwa et al. 2001; Chikoye et al. 2002; Roy et al. 2023). Labor is repeated in small amounts for the period of the initial phases of crop development, as soon as weeds need to be managed. Weeds that are permitted to nurture high

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requests, extra periods, and employment intended for the current regulator, though unsuccessful weeding affects significantly produce harm (Chikoye et al. 2004).

Despite criticism that its foliage remains pesticide in the surroundings, biochemical regulator consumption is recognized as an improved substitute for physical weeding for the reason that it is economical, more rapid, and offers improved regulators in good well-being as raised biological yield (Aladesanwa and Adejoro 2009; Kumawat et al. 2019; Iqbal et al. 2020; Imran et al. 2021). On the other hand, its letdown to deliver extended period weed regulator in maize in current periods has required investigation designed for another weed regulator package by maize growers in Ethiopia. Utilization of contact or systemic herbicide proceeding to establishing will guarantee that the maize field is allowed from weeds for the duration of the critical growth stage of the crop, which is up to around four weeks after sowing (Hall et al. 1992; Pergner and Lippert 2023). They necessitated to be added with hoeing to regulate permanent weeds or weeds evolving afterwards the herbicides have dissipated (Akinyemiju 1988; Merfield 2023; Kostina-Bednarz et al. 2023) since it is essential to look after maize crop from weed rivalry during the course of greatest of its development to safeguard determined yield (Aladesanwa and Adejoro 2009). Therefore, the purpose of the study was to test the efficacy of herbicides on several weed species and increase maize production.

2. MATERIALS AND METHODS

2.1. Description of Study Areas and Treatments

Field investigations were executed for the duration of the 2020/2021 main growing period in rain-fed circumstances at Holeta Agricultural Research station and Ejere farmer plot. Holeta is to be found 33km west of Addis Ababa at an altitude of 2400 m.a.s.l and surrounded by the geographic coordination of 9o00′N and 38o30′E. The district attains annual rainfall of 1144mm with the average smallest and highest temperatures fluctuating from 6°C to 22°C in turn (EIAR 2020). The soil of the experiment is clay loam with pH of 6.65, organic C (2.26%), accessible P2O5 (14.17mg.kg^{-1}), entire N (0.12%) and CEC of (17Cmol.kg^{-1}) (EIAR 2020). The soil and climatic situations observed for the period of the experimental season were fortunate for the passionate development of copious weed types that struggled with the crop plants. The climatic situations detected for the period of the experimental time, with an average rainfall of 1114.5mm, comparative moisture of 78.8% with mean least and extreme temperatures of 8°C and 25.2°C, in turn. Ejere is also located 40km from Holeta Agricultural Research's main location, which has comparable agro ecology with that of Holeta's main station.

The trial was in RCBD with three repetitions. The plot dimensions of 5m x 4m were used in the trial field. There were five herbicidal treatments applied as pre-emergence and a weed check was also included for comparison. The suggested doses of fertilizers and layout for maize were 150:100:7NPS kg/ha and 75x30cm, respectively maintained for all the treatments. A complete quantity of P_2O_5, and a partial dose of the NO_3 from sources of mixed fertilizer (NPS) and urea were applied at the time of sowing, and a leftover amount of nitrogen was added at the knee height period as per the recommended package of practices. The herbicides were functional as pre-emergence on principal time afterward planting using a Knapsack sprayer fixed using a flat fan nozzle by mixing 200 liters of water per ha.

2.2. Data Collection

Weed densities were determined by counting individual weed species manually by quadrant of sizes 25x25cm and converted to 1 m2 area bases. Plant height was measured with a meter of 4 arbitrarily designated and maize in every net plot area starting from the plant bottom to the top of the tassel at biological ripeness and the mean was executed for the analysis. Cob length was measured with a ruler from 4 randomly taken plants in every net plot area from the lower of the ear to the top of the ear of biological ripeness and the mean was used for the calculation. The grain yield was intended to subsequently from parting the sun-desiccated plants collected from everyone net plot and the yield was adjusted at 12.5% grain moisture content. Yield loss was also considered by the formula:

YL yield loss: YL% = $\frac{MGYT - GYPT}{MGYT} X100$

Where

MGPT = Maximum grain yield of a particular treatment, and GYPT = Grain yield of a particular treatment.

2.2. Data Analysis

The mean of everyone's records was tested by the normality test contingent on the Shapiro test (Pr<W) in the advance examination of alteration by means of the GLM technique of SAS (SAS 9.3 version). As the treatment properties are present substantial, averages were associated by means of Fisher's LSD test at a 5% level of significance (Gomez and Gomez 1984).

3. RESULTS AND DISCUSSION

3.1. Weed Flora Identification and Relative Density

The trial locations were infested with several weed species that remain noticeable in annual crops and perennials. Ten weed species were known at the trial sites in which all species were regarded as annuals (Table 1). The results showed that the fields were greatly infected with annual weeds. The highest relative weed density (18.28%) was intended from *Galinsoga pulviflora* while the smallest (4.7%) was perceived from *Plantago lanceoleta* L. which shows that annual weeds are more challenging in maize at tested locations (Table 1).

Table 1: Weed species, relative density, and life form in experimental fields

Weed species	Families	Weed density count (m^2)	Relative weed density (%)	Life form
*Polygonum nepalense*L.	Polygonaceae	284.00	15.83	Annual broadleaf
*Raphanus raphanistrum*L.	Brassicaceae	114.00	6.3	Annual broadleaf
Guizotia scabra (Vis) Chiov.	Compositae	118.00	6.5	Annual broadleaf
*Galinsoga pulviflora*Cav.	Compositae	328.00	18.28	Annual broadleaf
*Corrigiola capensis*Wild.	Plantaginaceae	244.00	13.60	Annual broadleaf
Caylusea abyssinica	Resedaceae	288.00	16.05	Annual broadleaf
*Plantago lanceoleta*L.	Plantaginaceae	86.00	4.7	Annual broad leaf
Spergula arvensis L.	Caryophyllaceae	117.00	6.6	Annual broad leaf
Medicago polymorpha	Fabaceae	117.00	6.6	Annual broad leaf
Phalaris paradoxa L.	Poaceae	98.00	5.4	Annual grass

3.2. Effects of Herbicides Application on Weed Densities at 45 days of Application at Holeta

3.2.1. *Polygonum nepalense* L.: The effect of herbicides was significant (P≤0.05) on the density of *P. nepalense* after herbicide application in Holeta and Ejere (Table 2). The lowest weed count of $2m^{-2}$ of *P. nepalense* was noted from the application of Surestart whereas the maximum density, $136m^{-2}$, was obtained at weed check. The mean weed species count of *P. nepalense* decreased by 134% as compared to control plots due to the application of Surestart at Holeta. The application of AGENT and Primagramgold 660SC exhibited statistically non-significant, which showed similar performance of herbicides against *P. nepalense* at Holeta. Similarly, the minimum weed density of $1.3m^{-2}$ of *P. nepalense* was recorded from the application of Surestart while the maximum number $137.3m^{-2}$ was obtained at weed check. Hence, the mean weed density of *P. nepalense* was decreased by 136% as compared to control plots due to the application of Surestart at Ejere. The application of AGENT and Primagramgold 660SC showed that statistically no significant difference there in Ejere. The result shows that the application of herbicides reduced weed density by killing most of the weeds in the treated plots. This is consistent with the observations of Shehzad et al. (2012) and Ghatrehsamani et al. (2023) who stated that herbicide application decreased weed density by eliminating most of the weeds in the field.

3.2.2. *Raphanus raphanistrum L:* The effect of herbicides was significant (P≤0.05) on the density of *R. raphanistrum* after herbicide application in Holeta and Ejere (Table 2). The minimum weed density 2 m^{-2} of *R. raphanistrum* was recorded from the application of Surestart whereas the maximum 52 m2 was obtained at weed check. The mean weed density of *R. raphanistrum* decreased by 50% as compared to control plots due to the application of Surestart at Holeta. The application of AGENT and Primagramgold 660SC showed that is statistically non-significant. Likewise, the minimum weed density 2m-2 of *R. raphanistrum* was recorded from the application of COYOTE 440SE and S-Maspor 960 EC, whereas the maximum number of 53.6 m^{-2} was obtained at weedy check. The mean weed density of *R. raphanistrum* decreased by 51.6% as compared to control plots due to the application of COYOTE 440SE and S-Maspor 960EC at Ejere. The application of COYOTE 440SE and S-Maspor 960EC revealed that it is statistically non-significant at Ejere. The result shows that treating plots with herbicides reduced weed density by killing most of the weeds in the treated plots. This is consistent with the findings of Fischer et al. 2002; Sharara et al. 2005; Rouge et al. 2023) who specified that herbicide application decreased weed density by eliminating most of the weeds in the field.

3.2.3. *Guizotia scabra*: The effect of herbicides was significant (P≤0.05) on the density of *G. scabra* after herbicide application in Holeta and Ejere (Table 2). The least weed density count m^{-2} of *G. scabra* was noted from treating of plots with Surestart, while the maximum number 148 m^{-2} was obtained at weedy check. The mean weed density of *G. scabra* was decreased by 148 and 149.4% as compared to control plots due to the application of Surestart at Holeta and Ejere respectively. The application of COYOTE 440SE, S-Maspor 960EC, and Primagramgold 660SC revealed statistically no significant difference. The result signifies that the application of herbicides reduced weed density by killing most of the weeds in the treated plots. This is analogous to the discoveries of Khan et al. (2016) who quantified that herbicide application decreased weed density by eliminating most of the weeds in the field.

3.2.4. *Galinsoga pulviflora*: The effect of herbicides was significant (P≤0.05) on the density of *G. pulviflora* after herbicide application in Holeta and Ejere (Table 2). The lowest weed count of 1.3 m^{-2} of *G. pulviflora* was recorded from the application of Surestart, while the maximum number 90m-2 was obtained at weedy check. The treatment of plots with COYOTE 440 SE, S-Maspor 960EC, and Surestart were shown to be statistically non-significant at Holeta. Correspondingly, the minimum weed count of 2 m^{-2}, of *G. pulviflora* was recorded from the application of Surestart, while the maximum number 91.3m^{-2} was obtained at weedy check. The mean weed count of *G. pulviflora* decreased by 88.7 and 89.3% as compared to control plots due to the application of Surestart at Holeta and Ejere, respectively. The application of COYOTE 440SE, S-Maspor 960EC, and Surestart revealed that there is statistically no significant difference at Ejere. The result shows the application of herbicides reduced weed density by killing most of the weeds in the treated plots. This is consistent with the findings of Carey and Kells (1995) and Chethan et al. (2023) who stated that herbicide application decreased weed density by eliminating most of the weeds in the field.

Table 2: Influence of herbicides on weed density at 45 days of application in Maize at Holeta and Ejere

Treatments	*Polygonum nepalense*		*Raphanus raphanistrum L.*		*Guizotia scabra*		*Galinsoga Pulviflora*		*Corrigiola capensis*	
	Holeta	Ejere	Holeta	Ejere	Holeta	Ejere	Holeta	Ejere	Holeta	Ejere
AGENT	34.6b	34b	7.3cd	7cd	30b	29.3b	52c	8.6cd	9.3cd	8.6cd
COYOTE 440SE	4d	3.3d	1.3d	2d	0.6c	1.3c	7.3d	17bc	18bc	17.bc
S-Maspor 960EC	12c	11.3c	1.3d	2d	1.3c	2c	7.0d	1.3c	1.3d	1.3c
Primagramgold 660SC	32b	31b	28.6b	28b	26b	26b	69.3b	21b	21.6b	21b
Surestart	2d	1.3d	12.6c	12c	0.0c	0.6c	1.3d	5.6d	6.0d	5.6d
Weedy check	136a	137a	52a	53.6a	148a	150a	90a	94.6a	94a	94.6a
LSD (5%)	3.8	5.22	7.82	7.5	6.56	6.9	9.29	9.5	10.8	9.5
CV (%)	5.76	7.89	24.96	23.6	10.04	10.9	13.5	21	23.7	21

Table 2: Continued…

Treatments	*Caylusea abyssinica*		*Plantago lanceoleta*		*Spergula arvensis*		*Medicago polymorpha*		*Phalaris paradoxa*	
	Holeta	Ejere	Holeta	Ejere	Holeta	Ejere	Holeta	Ejere	Holeta	Ejere
AGENT	4c	3.6c	7.3cd	6.6cd	18.6c	18c	17.3b	17b	12b	11.6b
COYOTE 440SE	0.6cd	1.3c	1.3d	2d	3.0d	3.6d	0.6c	1.3c	6c	5.6c
S-Maspor 960EC	0.6cd	2d	1.3d	2d	3.0d	3.6d	13bc	13bc	5c	4.6c
Primagramgold 660SC	58.6b	58b	28.6b	28b	38.6b	36.6b	50a	49.3a	5c	4.6c
Surestart	0.0d	0.6c	12.6d	12c	0.6d	1.3d	0.6c	0.0c	2.6c	2.3c
Weedy check	92.6a	94a	52a	53.6a	92.6a	92d	58.3a	58a	78a	77.3a
LSD (5%)	3.85	4.8	7.82	7.5	13.11	10.5	12.9	13.6	3.6	3.76
CV (%)	8.1	9.9	24.9	23	27.6	22.4	30.3	30.5	11.02	11.6

3.2.5. *Corrigiola capensis*: The effect of herbicides was significant (P≤0.05) on the density of *C. capensis* after herbicide application in Holeta and Ejere (Table 2). The lowest weed count of 1.3 m^{-2} of *C. capensis* was recorded from the application of S-Maspor 960 EC, while the maximum number 94 m^{-2} was obtained at weedy check at the application of AGENT and Surestart revealed that statistically no significant difference in Holeta. Correspondingly, a minimum weed density of 1.3 m^{-2} of *C. capensis* was recorded from the application of S-Maspor 960EC while the maximum number 94.6 m^{-2} was obtained at weedy check. The mean weed density of *C. capensis* was decreased by 92.7 and 93.3% as compared to control plots due to the application of S-Maspor 960EC at Holeta and Ejere, respectively. The application of AGENT and Surestart revealed that statistically no significant difference was found in Ejere. The result signifies that the application of herbicides reduced weed density by killing most of the weeds in the treated plots. This is consistent with the findings of Reddy et al. (2003) and Chethan et al. (2023) who stated that herbicide application decreased weed density by eliminating most of the weeds in the field.

3.2.6. *Caylusea abyssinica*: The effect of herbicides was significant (P≤0.05) on the density of *C. abyssinica* after herbicide application in Holeta and Ejere (Table 2). The lowest weed count of C. abyssinica was noted as a result of treatment of Surestart whereas the higher number, 92.6 m^{-2} was obtained at a weedy check. The treatment of plots with AGENT, COYOTE 440SE, and Surestart showed statistically non-significant differences in Holeta. Likewise, the lowest weed density of 0.6 m^{-2} for *C.abyssinica* was recorded from the application of Surestart, while the maximum count of 94 m^{-2} was obtained at weed check. The mean weed density of *C. capensis* decreased by 92.6 and 93.4% as compared to control plots due to the application of Surestart at Holeta and Ejere, respectively. The applications of AGENT, COYOTE 440SE, and Surestart showed statistically non-significant differences in Ejere. The result indicated that the application of herbicides reduced weed density by killing most of the weeds in the treated plots. This is consistent with the observation of Galloway and Weston (1996) who stated that herbicide application decreased weed density by eliminating most of the weeds in the field.

3.2.7. *Plantago lanceoleta*: The effect of herbicides was significant (P<0.05) on the density of *P. lanceoleta* after herbicide application in Holeta and Ejere (Table 2). The lowest weed count 1.3m^{-2} of *P. lanceoleta* was noted from the application of S-Maspor 960EC, and COYOTE 440SE while the maximum number 52m^{-2} was obtained at weedy check. Statistically non-significant differences were detected between applications of all tested herbicides except for Primagramgold 660SC in Holeta. Correspondingly, a minimum weed count 2m^{-2} of *P. lanceoleta* was recorded from the application of S-Maspor 960EC and COYOTE 440SE while the maximum number 53.6m^{-2} was obtained at weedy check. The mean weed count of *P. lanceoleta* decreased by 50.7 and 51.6% as compared to control plots due to the application of S-Maspor 960EC and COYOTE 440SE at Holeta and Ejere respectively. The result indicates that the application of herbicides reduced weed density by killing most of the weeds in the treated plots. This is consistent with the observation of Saudy et al. (2021) who quantified that herbicide application decreased weed density by eliminating most of the weeds in the field.

3.2.8. *Spergula arvensis*: The effect of herbicides was significant (P<0.05) on the density of *S. arvensis* after herbicide application in Holeta and Ejere (Table 2). A minimum weed count of 0.6 m^{-2} of S. arvensis was detected by the application of Surestart, whereas the maximum number 92.6 m^{-2} was obtained at weedy check. Statistically, no variations were observed between applications of COYOTE 440SE, S-Maspor 960EC, and Surestart. Similarly, a minimum weed density of 1.3m^{-2} of *S. arvensis* was recorded from the application of Surestart while the maximum number 92 m^{-2} was obtained at, weedy check in Ejere. The mean weed density of *S. arvensis* decreased by 50.7 and 51.6% as compared to control plots due to the application of S-Maspor 960EC and COYOTE 440SE at Holeta and Ejere respectively. There are statistically no variations detected between applications of COYOTE 440SE, S-Maspor 960EC, and Surestart. The application of herbicides causes mortality of weeds, and then consequently reduces weed density. This is consistent with the observation of Yadav et al. (2023) who stated that herbicide application decreased weed density by eliminating most of the weeds in the field.

3.2.9. *Medicago polymorpha*: The effect of herbicides was significant (P<0.05) on the density of *M. polymorpha* after herbicide application in Holeta and Ejere (Table 2). The lowest weed count 0.6m^{-2} of *M. polymorpha was* noted as a result of COYOTE 440SE and Surestart while the maximum number 58.3m^{-2} was obtained at control plots in Holeta. Likewise, there is no weed density of *M. polymorpha was* recorded from the application of Surestart even though the maximum number 58m^{-2} was obtained at the weedy check in Ejere. There are statistically no variations perceived between applications of COYOTE 440SE, S-Maspor 960EC, and Surestart. The mean weed density of *P. lanceoleta* was decreased by 57.7 and 58% as compared to control plots due to the application of COYOTE 440SE and Surestart at Holeta and Ejere, respectively. The application of herbicides causes mortality of weeds then consequently reduces weed density. This is consistent with the observation of Weston (1990) and Yadav et al. (2023) who stated that herbicide application decreased weed density by eliminating most of the weeds in the field.

3.2.10. *Phalaris paradoxa*: The effect of herbicides was significant (P<0.05) on the density of *P. paradoxa* after herbicide application in Holeta and Ejere (Table 2). The lowest weed count 2.6m^{-2} of *P. paradoxa was* detected in the application of Surestart while the maximum number 78m^{-2} was obtained in control plots. The lowest weed count, 2.3m^{-2} of *P. paradoxa was* noted from the application of Surestart whereas the maximum number 77.3m^{-2} was obtained at weedy check. The mean weed density of *P. paradoxa* decreased by 75.4 and 75% as compared to control plots due to the application of Surestart at Holeta and Ejere respectively. There are statistically no variations observed between applications of all herbicides excluding AGENT. The application of herbicides causes mortality of weeds then consequently reduces weed density. This is analogous to the observation of Singh et al. (2013) and Saudy et al. (2021) who stated that herbicide application decreased weed density by eliminating most of the weeds in the field.

3.3. Plant Height

Plant height was significantly (P≤0.05) influenced by the application of weed control methods (Table 3). The mean plant heights of 221.3 and 222cm produced at the application of Surestart exceeded the mean plant height of weedy check by 9.3 and 10% at Holeta and Ejere, respectively. Statistically, non-significant differences were observed due to the application of other treatments except for Surestart's application in both locations. This shows that plant height was more subjective by genomic than weed management. Bekele et al. (2018) and Ganvit et al. (2019) examined the enlarged plant height by means of the control plot as a consequence of severe opposition between plants which caused them to get longer in the exploration of light and the absence of accessibility of abundant growth-boosting aspects in the control plot that permitted the plants to progress in height, the struggle among weeds and crop for sunlight and space in control plots caused in elevated plants. The maize plant height was

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moderately higher in plots that were treated with herbicides for weed control than in the control plots where no herbicide was sprayed (Nawab et al. 1999; Hassan et al. 2010; Hunde et al. 2021; Memon et al. 2022).

3.4. Cob Length

Cob length was significantly (P≤0.05) influenced by the application of different herbicide treatments (Table 3). The maximum cob length (11.6cm) and (11.3cm) were noted at the application of Surestart in Holeta and Ejere correspondingly. However, the smallest cob length (4.5 cm) was noted from the control plots. The utilization of herbicides increased cob length significantly and consistently. Hence, the mean cob lengths of 11.6 and 11.3cm obtained due to the application of Surestart exceeded the mean cob length of the weedy check by 4 and 4.3% at Holeta and Ejere respectively. Statistically non-significant differences were observed as a result of weed control treatments except for control plots in all tested locations. The increase in cob length implies that improved weed control allows the plants to use more growth resources, but the smallest cob length in control plots may cause severe opposition of weeds. Analogous results were reported by Khan et al. (2012) and Mekonnen (2022) concluded that the longest cob length were herbicides were treated rather than control plots. Correspondingly, Kamal et al. (1983) and Ali et al. (2003) have found that the enlarged cob length when suitable weed control treatments containing herbicidal weed control was practical for weed control in the maize crop.

Table 3: Effect of herbicide application on plant height and cob length in maize at Holeta and Ejere

Treatments	Plant height (cm)		Cob length (cm)	
	Holeta	Ejere	Holeta	Ejere
AGENT	178b	177.3b	7.6b	8.3bc
COYOTE 440SE	180.4b	180.3b	10.3ab	11a
S-Maspor 960EC	198b	199.3ab	10ab	10.6ab
Primagramgold 660SC	208b	208.7ab	9.3ab	9abc
Surestart	221.3a	222a	11.6a	11.3a
Weedy check	212b	212ab	7.6b	7c
LSD (5%)	38.39	37.04	3.56	2.47
CV (%)	10.56	10	20.06	14.2

3.5. Grain Yield

Grain yield was significantly (P≤0.05) affected by application of different herbicides (Table 4). The mean yield of 4800kg/ha and 4833kg/ha were recorded from the application of Surestart at Holeta and Ejere respectively, whereas the minimum value of 260kg/ha was recorded from weedy check plots. Hence, the mean grain yield produced on the application of Surestart exceeded the mean grain yield of weedy check by 17.4 and 17.58 folds in Holeta and Ejere respectively. Statistically non-significant differences were noted between herbicides except for Surestart and Weedy Check in both locations. The maximum grain yield indicates that improved weed control allows the plants to exploit extra growth resources, while the minimum grain yield in control plots may be due to the severe struggles of weeds. This is consistent with the observations of Shah et al. (2018) and Shah and Wu (2019) who described that higher grain yield was attained wherever the smallest weed crop struggled for nutrients and water occurred. Khan (2002), Subhan et al. (2007) and Baffour-Ata et al. (2023) reported analogous results describing that the improved grain yield of the maize crop by controlling weeds with the application of herbicides.

Table 4: Effect of herbicide application on grain yield and yield loss in maize at Holeta and Ejere

Treatments	Grain yield (kg/ha)		Yield loss (%)	
	Holeta	Ejere	Holeta	Ejere
AGENT	3233b	3266b	35.3b	35.9b
COYOTE 440SE	3183b	3216b	36.3b	36.9b
S-Maspor 960EC	3266ab	3433ab	34.6bc	32.6bc
Primagramgold 660SC	2400b	2416b	52b	52.6b
Surestart	4800a	4833a	4.0c	5.2c
Weedy check	260c	260c	94.8a	94.8a
LSD (5%)	1543.8	2.22	30.87	28.6
CV (%)	29.7	27.6	29.6	30.6

3.6. Yield Loss

Yield loss was significantly (P≤ 0.05) affected by application of different herbicides (Table 4). The maximum yield losses of 94.8% were noted in control plots while minimum values of 4% and 5.2 % were recorded in Surestart-treated plots in Holeta and Medegudina respectively. Similarly, other herbicides also reduced yield loss compared to controlling plots. The decreased yield losses show improved weed control that, aids the plants to

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consume more growth resources while increasing yield loss in control perhaps extreme opposition of weeds. This is consistent with the observations of Abbas et al. (2018) and Ahmad et al (2023) who concluded the smallest yield loss was gained where the lowest weed crop opposition to nutrients and water happened.

Conclusion: Practical application of herbicides reduced weed dry weight and enhanced the grain yield of maize, which is principally attributed to advances in yield-related attributes due to enhanced weed control efficiency. Moreover, the increase in weed control is also attributed to decreased weed dry density as herbicides are poisonous to most weeds, causing mortality and fatty acids involved in the synthesis of protein and fatty acids. A significant increase in plant height, cob length, and grain yield was achieved as a result of the Surestart application. The application of Surestart proved the best pre-emergency herbicide in this experiment which was conducted in moisture-moisture-sufficient regions. Therefore, it is recommended to the farmers of the region for maximum seed production of maize with high nutritional quality. Based on the results, it is concluded that the maize variety 'Hora' should preferably be grown, and Surestart is applied soon after planting in rain-fed regions at the rate of (3L ha-1) with a spray volume of 200L ha-1 water is recommended pre-emergence herbicide for the control of various annual weeds in Maize.

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