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Evaluation of the effect of nicosulfuron at different times of application on the chemical component of maize (*Zea mays*)

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Abstract. *Tizhe TD, Alonge SO, Iortsuun DN, Adekpe DI, Batta K. 2022. Evaluation of the effect of nicosulfuron at different times of application on the chemical component of maize (*Zea mays*). Nusantara Bioscience 14: 122-127.* This study aimed to evaluate the effect of nicosulfuron at different concentrations and times of application on the chemical compositions of maize (*Zea mays* L.) grain. A field experiment was conducted during the 2019 and 2020 cropping seasons. Furthermore, using a split-plot design, maize seed was planted; and four different concentrations of nicosulfuron (50, 100, 150, and 200 g/ha) were applied at 3, 5, and 7 Weeks After Sowing (WAS). The maize grain was analyzed using standard procedures for its proximate amino acids and mineral contents. The results showed that the different concentrations of nicosulfuron and its time of application significantly affected the proximate compositions except for the ash content. The 5 WAS application time had the significantly highest protein, crude fiber, and moisture content with 11.35, 2.60, and 12.01%, respectively, and the lowest carbohydrate (70.58%) and crude fat (2.33%). The nicosulfuron was observed to significantly affect all the amino acids and mineral (except on N) contents of the maize grain with 100 g/ha. This study recorded the significantly highest content of almost all the amino acids with 100 g/ha, and 50 g/ha was the lowest. The 5 WAS virtually had the highest amino acids, while the 3 WAS the lowest. Therefore, nicosulfuron and time of application both have a significant effect on the proximate amino acids and Mg and Ca components of maize grain. That means that using nicosulfuron at concentrations precisely above 100 g/ha and at a time other than 5 WAS negatively affects the chemical components of maize grain.

Keywords: Amino acids, the effect of time of application, herbicide, the mineral content of maize grain, nicosulfuron, proximate composition

INTRODUCTION

Maize (*Zea mays* L.) is an annual plant believed to have originated from central Mexico about 7,000 years ago from wild grass and was by the native Americans transformed into a better source of food (Ranum et al. 2014). The crop was said to have been introduced to the African continent in the 16th century. And eventually spread to all parts of the continent around the 19th century. It is a staple food crop for over 1.2 billion people in Latin America and Sub-Saharan Africa (Anon 2021). It is grown in diverse environments and consumed by people with varying socio-economic backgrounds and food preferences in Africa (Olaniyan 2015). The maize consumption rate is estimated globally to be more than 116 million tonnes, with about 30% and 21% of the consumption rates occurring globally and in Sub-Saharan Africa (SSA). All parts of the crop can be used for food and non-food products. Besides being food for human consumption, it is also used for extraction of edible oil, as feed for poultry and livestock, starch, and glucose industry (Hawaldar and Agasimani 2012; Ahmad et al. 2021). It is also used mainly in Nigeria for beer brewing, the manufacturing of fabric and adhesives, and the pharmaceutical industries (Obi and Ihedigbo 1987). Maize grain contains approximately 72% starch, 10.4% protein, 4.8% fat, 17% ash, and 2.5% fiber (Farhad et al. 2009; Ranum et al. 2014).

Miafuron 75WG is a selective systemic post-emergence herbicide used in controlling weeds in maize fields. It has nicosulfuron as its active ingredient. It controls weeds by inhibiting the plant Acetolactate Synthase (ALS) enzyme. Inhibiting the ALS enzyme system blocks the production of the amino acids, valine and isoleucine, essential building blocks of proteins and other plant components (Anon 1990). The use of herbicides in the control of weeds in crop fields was reported to significantly affect crop grains' chemical components such as crude protein, crude fiber, fat, and ash (Mehmeti et al. 2016). Shaban et al. (2016) reported a significant increase in the carbohydrate content of maize grains due to the application of some herbicides (metribuzin and acetochlor). On the other hand, significantly lower valine, leucine, and isoleucine amino acids were observed in maize seedlings treated with chlorimuron-ethyl (Alla et al. 2008). Moreover, to determine the impact of atrazine, nicosulfuron, topramezone, and mesotrione on sweet corn nutritional quality, Cutulle et al. (2018) recorded an increase in the uptake of mineral elements like phosphorus, magnesium, and manganese by 8-75%, and protein content by 4-12%. However, literature reporting the effect of nicosulfuron at different concentrations and time of application on the amino acids and other chemical components of maize grain do not abound. Therefore, it was because of this that the idea of this study was initiated.

MATERIALS AND METHODS

Description of the study area

The research was carried out during the 2019 and 2020 cropping seasons in the research farm of the Department of Crop Science, the University of Adamawa State, Mubi, Adamawa State, Nigeria. The location of the research farm falls within the North Eastern region of Nigeria between latitude 10^{0}16'06" N and longitude 13^{0}16'01" E. This location has an elevation of 582 m above sea level; and occupies a land of about 725.85 Km^2. The area has a tropical climate with an average annual temperature of 32ºC; and lies within the Sudan Savannah vegetation zone of Nigeria. In addition, the area has an annual rainfall of about 1056 mm and an average relative humidity ranging from 28-45% (Adebayo 2004).

Source of seed for the experiment

The maize variety used in this study, SAMMAZ 17 was obtained from the Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria, Kaduna State, Nigeria.

Treatment and experimental design

In this study, the treatments consisted of four (4) concentrations of Miafuron 75WG (at 50, 100, 150, and 200 g/ha); two controls (hoe weeding and unweeded) and herbicide application time (at 3, 5, and 7 WAS). The experiment was managed in a split-plot design and was replicated three times. The time of herbicide application was managed on the main plots, while the herbicide concentrations and controls (sub-treatments) were laid on the sub-plots. A tractor was used to plow the experimental field and harrowed to obtain a good soil tilth, and then using a cow plougher, the field was ridged with an inter-row spacing of 75 cm apart.

Seed planting

Momtaz 45 WS seed dressing chemical treated on the maize seeds to avoid seed destruction by insects in the soil. That was followed by planting three seeds per hole of about 2 inches at an inter-row spacing of 75 cm and intra-row spacing of 25 cm. Finally, the seedlings were thinned to one plant per stand after two Weeks After Sowing (WAS).

Treatment and fertilizer application

Furthermore, using a back-mounted knapsack sprayer, the herbicides were applied at three periods (3, 5, and 7 WAS) at 50, 100, 150, and 200 g/ha concentrations. As a result, NPK (15:15:15) fertilizer was applied at the rate of 400 kg/ha at 2 WAS; next, urea fertilizer was applied at 130.43 kg N/ha at 5 WAS.

Collection of maize grain samples for proximate, amino acids, and mineral compositions analysis

The maize grain samples used for the proximate, amino acids and mineral composition analysis were obtained at harvest from the field according to the treatment plot when the maize grain was fully mature and dried thoroughly. The harvested maize of each cropping season was de-husked and then shade dried, shelled, grounded into powder, and placed in a well-labeled polythene black; then taken to the laboratory for analysis.

Data collection

Determination of proximate compositions:

The maize grain proximate compositions were analyzed using the methods described by AOAC (2020).

Determination of maize grain amino acid and mineral compositions:

The maize grain amino acid and mineral compositions were determined following the methods described by AOAC (2020).

Data analysis

The data generated from this study were subjected to analysis of variance (ANOVA) by a program of Statistical Analysis Software (SAS) version 9.0, and means with significant differences were separated using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Effect of nicosulfuron at different concentrations and times of application on the proximate compositions of maize grain

A comparison of the effect of different concentrations of nicosulfuron on maize grain proximate compositions during 2019 and 2020 trials showed that the highest carbohydrate content (72.32%) was recorded on a plot applied 50 g/ha of nicosulfuron, followed by 200 g/ha (71.93%) and the lowest (70.50%) was recorded at 100 g/ha. The lowest result was observed statistically at par with the two controls (unweeded and weeded plots) and 150 g/ha. The highest crude protein content (11.53%) was recorded at 100 g/ha but was statistically at par with those of the unweeded and weeded controls which had 11.19 and 11.37%, respectively, while the lowest protein content (10.49%) was recorded on plot applied concentration 200 g/ha which, however, was statistically similar to that of 150 and 50 g/ha. The significantly highest crude fat content (2.59%) was that of 200 g/ha, followed by that of weeded control which had 2.54%. In comparison, the lowest (2.24%) was recorded at 150 g/ha but was statistically at par with the unweeded and those of the other concentrations. The highest crude fiber (2.75%) was that of the weeded control, while the lowest (2.14%), which was only significantly different from the highest, was recorded at 200 g/ha. The moisture content (12.21%) recorded at 150 g/ha was the highest, but it was statistically similar to that of unweeded and 100 g/ha, while the lowest (11.25%) which was statistically at par with that of 50 and 200 g/ha was recorded at weeded control plot. However, the different concentrations of nicosulfuron had no significant difference in their effect on the ash content of the maize grain (Table 1).

The comparison of the effect of time of application of nicosulfuron on maize grain proximate compositions showed that the significantly highest crude protein

(11.35%), crude fiber (2.60%), and moisture (12.01%) contents were recorded on plots treated at 5 WAS; while the lowest protein (10.76%), fiber (2.18%) and moisture (11.57%) recorded at 3 and 7 WAS were statistically at par. The higher carbohydrate (71.70%) recorded at 7 WAS was significantly similar to 3 WAS, while the lowest (70.58%) was that of 5 WAS. The higher fat content (2.49%) was recorded on the plot treated at 3 WAS, but it was statistically at par with 7 WAS, while the lowest (2.33%) was recorded at 5 WAS. The 3, 5, and 7 WAS application periods had no statistically significant effect on the maize grain ash content (Table 1).

Comparing the effect of year on the proximate components showed that 2019 had the significantly highest contents of carbohydrate (71.92%) and crude fiber (2.43%), while 2020 had the highest of crude protein (11.21%) and moisture (12.33%). On the fat and ash contents, however, the 2019 and 2020 cropping seasons had no significant difference (Table 1).

The interactions between year and concentrations and year and time of application only significantly affected carbohydrate, fiber and moisture, and fiber and moisture contents, respectively. In comparison, the interactions between concentrations and time of application; and year, concentrations, and time of application did not have a significant effect only against ash content (Table 1).

Effect of nicosulfuron at different concentrations and times of application on the amino acids composition of maize grain

The effect of different concentrations of nicosulfuron on the amino acids content of maize grain comparison indicated that isoleucine (0.81 g/100 g), leucine (1.06 g/100 g), lysine (1.12 g/100 g), methionine (1.44 g/100 g), phenylalanine (1.32 g/100 g), tryptophan (1.33 g/100 g), arginine (1.39 g/100 g) and alanine (1.49 g/100 g) were statistically significantly the highest at 100 g/ha; histidine (0.74 g/100 g), threonine (1.18 g/100 g), aspartic acid (1.30 g/100 g), cysteine (1.50 g/100 g), proline (1.64 g/100 g) and tyrosine (1.89 g/100 g) recorded at 200 g/ha were significantly the highest; valine (1.41 g/100g), glutamic acid (1.77 g/100 g) and glycine (1.52 g/100 g) recorded at 150 g/ha were the highest, while the lowest of most of these amino acids were recorded at concentration 50 g/ha of nicosulfuron (Table 2).

The effect of time of application of nicosulfuron on the amino acids content of the maize grain comparison showed that 5 WAS had the statistically significantly highest content of all the amino acids while 3 WAS had the significantly lowest content of amino acids like; isoleucine (0.60 g/100 g), methionine (0.96 g/100 g), phenylalanine (0.91 g/100 g), arginine (1.07 g/100 g), glutamic acid (1.15 g/100 g) and tyrosine (1.26 g/100 g); and 7 WAS had the lowest of histidine (0.60 g/100 g), leucine (0.69 g/100 g), valine (1.15 g/100 g), aspartic acid (0.90 g/100 g), cysteine (0.95 g/100 g), proline (1.20 g/100 g) and serine (1.28 g/100 g). The lower content of lysine, threonine, tryptophan, and glycine recorded at 3 and 7 WAS were significantly similar. Comparing the effect of year on the amino acids content of the maize grain showed that 2019 had the significantly highest content of all the amino acids except cysteine, glutamic acid, glycine, serine, and tyrosine (Table 2).

Interactions between year and concentration; between year and time of application; between concentration and time of application; and between year, concentration, and time of application all had a significant effect on all the amino acid content of the maize grain except against serine (Table 2).

Table 1. Effect of nicosulfuron on the proximate compositions of maize grain obtained from the 2019 and 2020 cropping season

Treatment	Proximate compositions (%)					
	Carbohydrate	Protein	Fat	Ash	Fibre	Moisture
Concentration (g/ha) – (C)						
UW	70.89c	11.19ab	2.35bc	1.14a	2.31b	12.13a
W	70.98c	11.37ab	2.54ab	1.10a	2.75a	11.25b
50	72.32a	10.64c	2.32c	1.15a	2.20b	11.37b
100	70.50c	11.53a	2.32c	1.16a	2.29b	12.20a
150	71.27bc	10.91bc	2.24c	1.16a	2.22b	12.21a
200	71.93ab	10.49c	2.59a	1.15a	2.14b	11.70b
SE±	0.29	0.17	0.07	0.07	0.08	0.15
Time App (WAS) – (TA)						
3	71.67a	10.97b	2.49a	1.13a	2.18b	11.57b
5	70.58b	11.35a	2.33b	1.14a	2.60a	12.01a
7	71.70a	10.76b	2.36ab	1.16a	2.18b	11.85ab
SE±	0.21	0.12	0.05	0.05	0.06	0.11
Year – (Y)						
2019	71.92a	10.83b	2.39a	1.15a	2.43a	11.28b
2020	70.71b	11.21a	2.40a	1.13a	2.21b	12.33a
SE±	0.17	0.10	0.04	0.04	0.05	0.05
Interactions						
Y x C	*	NS	NS	NS	*	*
Y x TA	NS	NS	NS	NS	*	*
C x TA	*	*	*	NS	*	*
Year x C x TA	*	*	*	NS	*	*

Note: Means followed by the same alphabet within a treatment group are not statistically different at p≤0.05. Key: *: statistically significantly different; NS: No significant difference; UW: Unweeded; W: Weeded

Table 2. Effect of nicosulfuron on the amino acids compositions of maize grain obtained from the 2019 and 2020 cropping season

Treatment	Amino acids (g/100g)								
	HIS	**ISO**	**LEU**	**LYS**	**MET**	**PHA**	**THR**	**TPY**	**VAL**
Concentration (g/ha) – (C)									
UW	0.60c	0.70b	0.67e	0.71d	0.86d	0.88e	0.91d	1.11c	1.11d
W	0.52e	0.54e	0.88b	0.77c	0.94c	0.90d	0.86e	1.05d	1.14d
50	0.63b	0.64c	0.57f	0.62e	0.83e	0.84f	0.78f	0.97e	1.23c
100	0.64b	0.81a	1.06a	1.12a	1.44a	1.32a	1.07b	1.33a	1.33b
150	0.56d	0.56d	0.73d	0.79c	0.99b	0.98c	0.99c	1.05d	1.41a
200	0.74a	0.69b	0.83c	0.86b	0.99b	1.01b	1.18a	1.22b	1.22c
SE±	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
Time APP (WAS) - (TA)									
3	0.62a	0.60c	0.76b	0.76b	0.96c	0.91c	0.89b	1.03b	1.24b
5	0.63a	0.71a	0.93a	0.91a	1.06a	1.10a	1.12a	1.30a	1.34a
7	0.60b	0.66b	0.69c	0.76b	1.01b	0.95b	0.88b	1.04b	1.15c
SE±	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
Year – (Y)									
2019	0.63a	0.69a	0.85a	0.92a	1.12a	1.10a	1.04a	1.23a	1.35a
2020	0.60b	0.62b	0.73b	0.71b	0.90b	0.88b	0.89b	1.02b	1.13b
SE±	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.01	0.01
Interactions									
Y x C	*	*	*	*	*	*	*	*	*
Y x TA	*	*	*	*	*	*	*	*	*
C x TA	*	*	*	*	*	*	*	*	*
Y x C x TA	*	*	*	*	*	*	*	*	*
	ARG	**ALA**	**ASP**	**CYST**	**GLU**	**GLY**	**PRO**	**SER**	**TYR**
Concentration (g/ha) – (C)									
UW	1.32b	1.29c	0.88e	0.96d	1.09c	1.01e	1.11d	1.16a	1.19e
W	1.22c	1.35b	0.93d	0.97d	1.08c	1.10d	1.12d	1.13a	1.21e
50	1.05d	1.07e	0.88e	0.88e	1.09c	1.00e	1.16c	1.24a	1.27d
100	1.39a	1.49a	1.01c	1.40c	1.46b	1.50b	1.56b	7.70a	1.42c
150	1.22c	1.19d	1.06b	1.44b	1.77a	1.52a	1.55b	1.19a	1.75b
200	1.33b	1.37b	1.30a	1.50a	1.48b	1.45c	1.64a	1.73a	1.89a
SE±	0.01	0.01	0.01	0.01	0.01	0.01	0.01	2.58	0.01
Time App (WAS) – (TA)									
3	1.07c	1.12b	0.93b	1.12b	1.15c	1.13b	1.26b	1.41b	1.26c
5	1.45a	1.38a	1.19a	1.50a	1.64a	1.52a	1.62a	1.74a	1.77a
7	1.24b	1.38a	0.90c	0.95c	1.19b	1.13b	1.20c	1.28c	1.34b
SE±	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1.83	0.01
Year – (Y)									
2019	1.29a	1.28b	1.01a	1.15b	1.29b	1.24b	1.36a	1.41b	1.39b
2020	1.22b	1.31a	1.01a	1.23a	1.36a	1.28a	1.36a	3.54a	1.52a
SE±	0.01	0.00	0.01	0.01	0.01	0.00	0.00	1.49	0.01
Interactions									
Y x C	*	*	*	*	*	*	*	NS	*
Y x TA	*	*	*	*	*	*	*	NS	*
C x TA	*	*	*	*	*	*	*	NS	*
Y x C x TA	*	*	*	*	*	*	*	NS	*

Note: Means followed by the same alphabet within a treatment group are not statistically different at p≤0.05. Key: *: statistically significantly different; WAS: Week after Sowing; UW: Unweeded; W: Weeded; HIS: Histidine; ISO: Isoleucine, LEU: Leucine; LYS: Lysine; MET: Methionine; PHA: Phenylalanine; THR: Threonine; TPY: Tryptophan; VAL: Valine; ARG: Arginine; ALA: Alanine; ASP: Aspartic acid; CYST: Cysteine; GLU: Glutamic acid; GLY: Glycine; PRO: Proline; SER: Serine; TYR: Tyrosine

Effect of nicosulfuron at different concentrations and times of application on the mineral composition of maize grain

Table 3 shows the different concentrations of nicosulfuron had no significant difference in their effect on the N and Ca content of the maize grain. However, the Mg content (0.15%) recorded in maize grain obtained from the unweeded control plot was significantly the highest, while the lowest Mg content (0.06%) at 100 and 200 g/ha was statistically at par with those of the weeded, 50 and 150 g/ha.

The effect of time of application of nicosulfuron at different concentrations on the N, Ca, and Mg contents of the maize grain comparison showed that the 3, 5, and 7 WAS time of application had no statistically significant difference in their effect on the N and Ca contents of the maize grain. Moreover, a significant difference was observed in the Mg content, with 3 WAS recording the highest Mg content (0.13%) while 7 WAS was the lowest (0.06%). However, that was statistically significantly similar to 5 WAS, which had 0.07% (Table 3).

Table 3. Effect of nicosulfuron on the N, Ca, and Mg content of maize grain obtained from the 2019 and 2020 cropping season

Treatment	Mineral composition (%)		
	N	Ca	Mg
Concentration (g/ha) – (C)			
UW	1.77b	0.18a	0.15a
W	1.81ab	0.17a	0.07b
50	1.71ab	0.18a	0.07b
100	1.82a	0.16a	0.06b
150	1.71ab	0.16a	0.10b
200	1.74ab	0.17a	0.06b
SE±	0.03	0.02	0.02
Application Time (WAS) – (AT)			
3	1.75a	0.19a	0.13a
5	1.80a	0.17a	0.07b
7	1.74a	0.16a	0.06b
SE±	0.02	0.01	0.01
Year – (Y)			
2019	1.75a	0.17a	0.06b
2020	1.77a	0.17a	0.11a
SE±	0.02	0.01	0.01
Interaction			
Y x C	NS	NS	*
Y x AT	NS	NS	*
C x AT	*	NS	*
Y x C x AT	*	NS	*

Note: Means along the column with the same letter(s) are not statistically significantly different at $p \leq 0.05$. Key: *: Statistically significantly different; NS: Not significant; UW: Unweeded; W: Weeded

A comparison of the effect of year on the three mineral content of the maize grain showed that year had no significant effect on the N and Ca content of the maize grain. Still, there was a significant effect on Mg, with 2020 recording the highest Mg content with 0.11% (Table 3).

Interactions between year and concentration, year and time of application only had significantly effected on the Mg content of the maize grain, while interactions between concentrations and time of application; and year, concentrations, and time of application only had a significant effect on the N and Mg contents of the maize grain (Table 3).

Discussion

Assessing the effect of nicosulfuron at the different concentrations on the proximate compositions of Sammaz 17 during the 2019 and 2020 trials, indicated a significant effect of the nicosulfuron concentrations on most of the proximate components of the maize variety. The highest carbohydrate, protein, crude fat, moisture, and crude fiber were recorded at concentrations 50, 100, 200, and 150 g/ha and weeded plots, respectively. The significantly higher content of most of these proximate compositions in maize grain obtained from plots treated with different concentrations of nicosulfuron and weeded control could be due to the effective weed control achieved as a result of the application of the herbicide. A similar amount of carbohydrate recorded in a maize grain that was treated with herbicide was reported by Ritter and Menbere (2001). A protein content between 4-12% was recorded in the grain of sweet maize variety treated with herbicides like nicosulfuron and atrazine (Cutulle et al. 2018). Chaudhary et al. (2010) also reported a higher percentage of protein in the grain of maize cultivated on a plot treated with herbicide than that of hand hoeing and unweeded controls. The application of herbicides which include: Sekator, Lintur 70 WG, Granstar 75 WG, and Mustang in wheat fields, was reported to bring about a significant increase in the proximate compositions like crude protein, crude fat, ash, and crude fiber of the wheat grain (Mehmeti et al. 2016). The effect of time of application of the nicosulfuron on the proximate compositions of the maize variety comparison showed that, time of herbicide application had a significant effect on most of the proximate components of the maize grain, with crude protein, crude fiber, and moisture contents being high at 5 WAS; carbohydrate at 7 WAS; and crude fat at 3 WAS. The significantly highest crude protein, crude fiber, and moisture recorded at 5 WAS time of application might be due to the effective weed control observed at that stage. The timely application of herbicides to control weeds in maize fields significantly improved the quality of maize (Karkanis et al. 2020).

The analysis of the amino acid contents of the maize variety applied nicosulfuron at different concentrations showed that the nicosulfuron had a significant difference in their effect on all the amino acids, except on serine. The significantly highest essential amino acids, which include: histidine, lysine, methionine, phenylalanine, isoleucine, leucine, threonine, tryptophan, arginine, and valine; and non-essential like alanine were recorded at the recommended concentration of the nicosulfuron, while the highest of most of the non-essential were recorded at the highest concentration of the herbicide. The determination of the effect of time of application of the nicosulfuron on the amino acids content of the maize variety indicated that the statistically significantly highest content of virtually all the amino acids, both the essential and non-essential, were recorded at the 5 WAS period of treatment application. That authenticates the significantly highest protein content of maize variety recorded at the 5 WAS, as shown in Table 1, as the increase in protein means an increase in amino acids (El-Sobki and Salem 2021). This finding might not be far from the fact that the herbicide had less injury on the plant; there was an effective weed management, especially at higher concentrations of the herbicide at that period of application. The post-emergence application of herbicides in the control of weeds in wheat and maize seedlings resulted in a significant increase in some of the amino acid content of the two crops, especially the butachlor and metribuzin-treated ones (Alla et al. 2008).

The analysis of the mineral content of the maize variety applied nicosulfuron at different concentrations showed that the nicosulfuron concentrations had no significant difference in their effect on the N and Ca content of the maize grain. That contradicts the finding of Omovbude et al. (2017), who reported a significant increase in mineral content like N, Ca, P, K, and Mg. This contradiction might be due to differences in herbicide type and application period; crops react differently to different herbicides (Soltani et al. 2007). However, comparing the mineral content according to the time of treatment application indicated that the application period had no statistically significant difference in its effect on the N and Ca content except on Mg. This result proved right the non-significance of the effect of nicosulfuron concentrations and time of application on the ash content of the maize variety, as shown in Table 1. A similar finding was reported by Barbas and Sawicka (2020) when they discovered a nonsignificant difference in the effect of concentrations and time of application of some pre and post-emergence herbicides on the mineral content of some cereal crops.

In conclusion, nicosulfuron at concentrations of 50-200 g/ha significantly affects the proximate compositions of the Sammaz 17 maize variety. The time of nicosulfuron application also has a significant effect on most of the proximate compositions of the maize variety, with 5 WAS having the highest of most of the proximate components than 3 and 7 WAS. On the amino acid content of the maize grain, nicosulfuron at concentrations 50-200 g/ha has a significant effect, with concentration 100 g/ha (recommended concentration) recording the highest of all the essential and some of the non-essential amino acids content than other concentrations. The 3, 5, and 7 WAS time of nicosulfuron application also significantly affects the amino acids contents of the maize grain, with 5 WAS having the majority of the significantly highest amino acids content than 3 and 7 WAS. Concentrations 50-200 g/ha of nicosulfuron have no significant effect on the Ca and N of Sammaz 17 maize grain, while the 3, 5, and 7 WAS periods of application have no significant effect on the Ca and N, but on Mg content of the maize.

Therefore, nicosulfuron at different concentrations and times of application significantly affect the proximate and amino acid components of Sammaz 17 more than its Ca and N mineral content. Concentration 100 g/ha and 5 WAS time of application give the highest content of all essential amino acids content of Sammaz 17 maize grain. That means that using nicosulfuron herbicide at the recommended concentration (100 g/ha) to control weeds at 5 WAS in maize fields allows the plants to produce sufficient amino acids. Those amino acids produced, especially the essential ones could pave the way for synthesizing the necessary materials needed for increased growth and yield.

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