

Influence of pendimethalin and hand weeding on mineral composition of maize, cowpea and their intercrop

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Abstract

Weed competition has been a major challenge limiting crop yield especially in intercropping systems. Information on the use of chemicals for weed control in intercropping systems appears scanty. The aim of this study was to investigate the efficacy of pendimethalin (P) at 1 kg active ingredient/ha, and hand weeding (HW) on mineral contents of the harvested grains and effects of various weed control treatments in maize, cowpea, and their intercrop. Field experiments were carried out during the 2017 and 2018 rainy seasons. The field layout followed complete randomized block design with three replicates. There were eight treatments: Sole Maize/Cowpea + P, Sole Maize/Cowpea + P + 1HW at 3 weeks after sowing (WAS), Sole Maize/Cowpea + P+ 2HW at 3 and 6 weeks after sowing (WAS), Sole Maize/Cowpea weedy check, Intercrop + P, Intercrop + P + 1HW at 3WAS, Intercrop + P + 2HW at 3 and 6 WAS and Intercrop weedy check. It was observed that, P+1HW and P+2HW in both cropping systems have significant effects ($p < 0.05$) and effectively control weed and increase the mineral contents in maize, cowpea, and their respective intercrop. The study revealed that, the mineral composition of maize and cowpea grains were improved by using pendimethalin with supplementary hand weeding. The study recommends that farmers should adopt intercropping maize with cowpea using pendimethalin plus one supplementary hand weeding at 3 WAS.

Keywords: Hand weeding, Pendimethalin, Mineral, Maize, Cowpea, Intercrop

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Introduction

Population explosion and consequently community expansions in developing countries are the major cause of reduced availability of arable land in spite of increasing demand for agricultural products (Seran and Brintha, 2009). Intercropping is one of several farming techniques that have been identified and being practiced globally, especially in West Africa, in order to achieve adequate food supply for these teeming populations. A weed is a plant that grows in a place where it is not desirable, some are crop and location specific, while others thrive in a wide range of habitats (Olorunmaiye *et al.*, 2011), and their negative economic effects on agricultural or natural systems remain obvious (Olorunmaiye *et al.*, 2013). Apart from increasing the production cost, they also harbour disease and insect pests by serving as alternative hosts (Chauhan, 2020). Weed infestation is a vital factor that is responsible for low crop yield (Tahir *et al.*, 2009; Yadav *et al.*, 2017). Weed type, density, as well as their persistence and crop management practices are some of the factors that determine the magnitude of crop yield loss.

Intercropping is a planting strategy that involves the cultivation of multiple crops simultaneously on the same plot of land (Anderson *et al.*, 2013; Kermah *et al.*, 2017). It is also referred to as the cultivation of two or more crop species at the same time in the same field (Dwivedi *et al.*, 2015). Commonly, in West Africa, cereals such as maize (*Zea mays*), millet (*Pennisetum glaucum*) and sorghum (*Sorghum bicolor*) are often intercropped with leguminous crops like beans (*Phaseolus vulgaris*), cowpea (*Vigna unguiculata*), groundnut (*Arachis hypogea*), soybean (*Glycine max*) and pigeon pea (*Cajanus cajan*). (Carruthers *et al.*, 2000 ; Audy-Reddy, 2003; Bilalis *et al.*, 2005; Ibrahim *et al.*, 2014). This combination of cereal and legumes is popular among farmers in the region probably due to legumes' ability to combat erosion and raise soil fertility levels (Matusso *et al.*, 2012). Intercropping helps to mitigate risk of crop failure and legume in cereal-legume intercrop can provide food for farmers in case the main crop fails to produce yield due to erratic distribution of rainfall (Rusinamhodzi *et al.*, 2012). Maize (*Zea mays* L.) belongs to the family Poacea and has been ranked second in the world's cereal production (Awopegba *et al.*, 2017). Maize is well recognized as a common component in most intercropping systems. Maize has widely been used as a cereal in intercropping practices and commonly combined with dissimilar legumes (Maluleke *et al.*, 2005). Cowpea (*Vigna unguiculata* (L) Walp) is a leguminous crop belonging to the Family Fabaceae, sub family Pappilinaeae.

Cowpea is the most widely cultivated and consumed grain legumes especially in Asia and tropical Africa (Geberemariam *et al.*, 2009). Leguminous crops tend to enhance soil fertility by supplementing soil nitrogen through its atmospheric fixation (Tian *et al.*, 2000). A lot of emphasis has been laid on effects of weed control on yield, while paying little attention on the nutrient composition and nutrient uptake of crops by various weed control methods (Omobude *et al.*, 2017). Therefore, this study investigated the effects of pendimethalin and supplementary hand weeding on the mineral composition of maize, cowpea, and their intercrop.

Materials and Methods

Source of Maize and Cowpea

The maize grains (*Zea mays* L.) variety SAMMAZE-33 and the cowpea seeds (*Vigna unguiculata* L. Walp) variety SAMPEA-7, (IAR 48), were purchased from the Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria. Seedrex and pendimethalin were bought from an Agrochemical Shop in Aminlegbe, Ilorin, Kwara State.

Site Description

The study was carried out in 2017 and 2018 cropping season at the botanical garden, located at the University of Ilorin, Ilorin in the Southern Guinea savannah ecological zone of Kwara State (Latitude 8° 24'N, and 8° 36'N and Longitude 4° 10'E, and 4° 36'E), Nigeria (Abdulkareem, *et al.*, 2015), and is 307 m above sea level. The climate of the research area is characterized by mean annual precipitation of 98.8 mm and mean annual temperature of 26.2 °C. The mean monthly meteorological data (rainfall, ambient air minimum and maximum temperature, and relative humidity) of 2017 and 2018 cropping seasons (May – July) for Ilorin were obtained from Lower Niger River Basin Development Authority, Ilorin, Kwara State.

Experimental Layout and Treatment Details

The plot layout followed a randomized complete block design with three replicates. The gross plots measured 41.5m x 14m in dimension. Each block measured 4.0 m x 3.0 m (12 m²). Cowpea seeds variety (SAMPEA -7) were sown at 0.3m within a row and maize seeds variety sown at 0.4m within a row and the ridges were 0.75m apart. Cowpea - maize intercrop i.e planting both crops on same row (50% cowpea + 50% maize) were sown at 0.3m within a row. Maize and cowpea were planted on the same

day at the depth of 0.3m. The spacing gave plant populations of 33,000 per hectare in sole maize and 40,000 per hectare in sole cowpea. In intercrop gave a combined plant population of 40,000 per hectare. The space between blocks and experimental units was 0.5 m and 1.0 m, respectively. The soil characteristics of the experimental field was found to be sandy loamy. There were eight (8) treatments: T1= Maize/Cowpea sole crop with herbicide weed control; T2= Maize/Cowpea sole crop with herbicide followed by one hand weeding at 3 weeks after sowing (WAS); T3 = Maize/Cowpea sole crop with herbicide followed by two- hand weeding at 3 and 6 (WAS); T4 = Maize/Cowpea sole weedy check; T5 = Maize + Cowpea intercrop crop with herbicide weed control; T6 = Maize + Cowpea intercrop with herbicide with one hand weeding at 3 WAS; T7 = Maize + Cowpea intercrop with herbicide with two-hand weeding at 3 and 6 WAS; T8 = Maize + Cowpea intercrop weedy check.

Data Collection

Mineral Analysis of Air-Dried Maize and Cowpea

The mineral analysis was carried out using the AOAC method (AOAC, 2000). About 10 g of food sample (dried maize and cowpea) was separately put in a pre-acid washed and oven-dried crucibles. The samples were then dried to a constant weight in an oven at 50 °C. The dried food samples were allowed to cool in a desiccator at room temperature, ground using a porcelain mortar and pestle and sieved through a 2 mm mesh plastic sieve. For each food sample, 2g of ground food sample was accurately weighed using an electronic weighing balance and transferred in to a clean a beaker and digested. To each weighed food sample, 7ml of concentrated nitric acid and 21ml of concentrated hydrochloric acid were added and heated at 200 °C on a hot plate in a fume hood chamber, until there were no brown

fumes. The digested sample solution was filtered using Whatman 0.42 µm filter paper in a 50ml volumetric flask and made up to the mark with distilled water. The filtrate was each put in to 60ml pre-acid cleaned plastic bottles and the metal contents were analysis using Buck Scientific Atomic Absorption Spectrophotometer (Model Bulk 210). Phosphorous was analyzed using Flame Photometer (Model Corning 400).

Data Analysis

Data collected were analyzed using One Way Analysis of Variance (ANOVA) of Statistical Package for Social Science (SPSS) software version 20. The data was reported as an average of the two cropping seasons. The level of significance used in the F ratio was $p < 0.05$. Where F ratio is significant, the differences between the treatment means were separated using Duncan Multiple Range Test (DMRT) (Duncan, 1955).

Results

Mineral composition of maize

Calcium (Ca)

Table 1 represents the results of elemental analysis of harvested maize grain as influenced by pendimethalin and supplementary hand weeding in mg/100g. The calcium content in maize grains was significantly ($P \leq 0.05$) affected by weed control methods, it ranged from 14.51-25.62 mg/100g. The maximum value was observed in sole maize treated with pendimethalin plus two hand weeding at 3 and 6 WAS (25.62 mg/100g) followed by intercrop plot treated with pendimethalin plus one hand weeding at 3 WAS (19.43 mg/100g), while the lowest was observed in weedy check.

Table 1. Effect of pendimethalin and hand weeding on mineral composition of maize

Treatment	Calcium	Magnesium	Potassium	Sodium	Manganese	Iron	Copper	Zinc	Phosphorus	Nitrogen
T1=(M+H)	15.44 ^{de} ±0.35	21.84 ^{bcd} ±2.05	63.14 ^{cd} ±3.04	39.23 ^{cd} ±0.69	0.14 ^c ±0.01	0.65 ^d ±0.03	0.04 ^{bc} ±0.00	0.63 ^{bc} ±0.00	0.65 ^e ±0.01	2.03 ^{cd} ±0.10
T2=(M+H+h)	21.84 ^b ±2.07	22.88 ^{abc} ±1.01	66.67 ^b ±1.40	40.61 ^c ±0.71	0.15 ^{bc} ±0.01	0.84 ^c ±0.04	0.05 ^{ab} ±0.00	0.67 ^a ±0.01	0.91 ^b ±0.02	2.12 ^{bc} ±0.09
T3=(M+H+2h)	25.62 ^a ±0.82	23.42 ^{ab} ±0.05	69.70 ^a ±1.30	45.30 ^a ±1.33	0.15 ^b ±0.00	1.44 ^a ±0.06	0.05 ^a ±0.01	0.68 ^a ±0.00	1.03 ^a ±0.03	2.27 ^{ab} ±0.07
T4=(M+Wd)	14.51 ^e ±0.51	20.58 ^{cd} ±2.43	59.56 ^{ef} ±1.02	36.70 ^e ±0.41	0.14 ^c ±0.00	0.39 ^f ±0.01	0.03 ^{cd} ±0.00	0.61 ^c ±0.02	0.63 ^e ±0.04	1.60 ^e ±0.08
T5=M(l+H)	15.93 ^{de} ±0.95	21.79 ^{bcd} ±0.71	61.74 ^{de} ±1.02	36.27 ^e ±0.53	0.11 ^d ±0.01	0.58 ^e ±0.01	0.03 ^d ±0.00	0.62 ^{bv} ±0.00	0.71 ^d ±0.01	2.02 ^{cd} ±0.25
T6=M(l+H+h)	16.58 ^d ±0.02	22.04 ^{bcd} ±0.27	65.63 ^{bc} ±1.15	38.65 ^d ±1.71	0.14 ^{bc} ±0.00	0.87 ^c ±0.03	0.03 ^{cd} ±0.01	0.62 ^{bc} ±0.01	0.78 ^c ±0.02	2.10 ^{bcd} ±0.10
T7=M(l+H+2h)	19.43 ^c ±0.32	24.57 ^a ±1.16	68.11 ^{ab} ±0.87	42.50 ^b ±0.57	0.16 ^a ±0.01	1.08 ^b ±0.03	0.04 ^{bc} ±0.00	0.66 ^{ab} ±0.06	0.91 ^b ±0.04	2.41 ^a ±0.12
T8=M(l+Wd)	14.53 ^e ±0.54	20.02 ^d ±1.06	58.90 ^f ±1.11	35.15 ^e ±0.80	0.10 ^d ±0.00	0.42 ^f ±0.05	0.03 ^d ±0.00	0.61 ^{bc} ±0.02	0.63 ^e ±0.03	1.87 ^d ±0.09
Mean	17.99±3.89	22.14±1.80	64.18±4.00	39.30±3.35	0.14±0.02	0.78±0.34	0.04±0.01	0.64±0.03	0.78±0.15	2.05±0.26

Magnesium (Mg)

The magnesium concentration was significantly affected by weed control practices (Table 1) The concentration was found to be between 20.02 - 24.57 mg/100g in both cropping methods. The highest value was recorded in intercropped maize treated with pendimethalin plus two hand weeding at 3 and 6 WAS (24.57 mg/100g) and the least was obtained in the intercrop weedy check (20.02 mg/100g)

Potassium (K)

Potassium was the most abundant and was significantly higher than all other elements analyzed. The value of potassium concentration ranged from 58.90 – 69.70 mg/100g. All weed control treatments recorded higher potassium concentrate than the weedy check with highest value observed in sole plot treated with pendimethalin plus two hand weeding at 3 and 6 WAS (69.70mg/100g) and the lowest was noticed in weedy check (58.90 mg/100g) (Table 1).

Sodium (Na)

The sodium content (Table 1) was found to range from 35.15 - 45.30 mg/100g with the highest being found in sole plot treated with pendimethalin plus two hand weeding at 3 and 6 WAS (45.30 mg/100g), followed by similar treatment in the intercropping system (42.50 mg/100g). The sole pendimethalin in the intercrop (39.23 mg/100g) and the weedy check (36.70 mg/100g) showed values that were statistically similar and lower compared to other weed control methods.

Manganese (Mn)

The concentration of manganese (Mn) in maize grains as indicated in Table 1, ranged from 0.10 - 0.16 mg/100g in both cropping methods. The maximum concentration of magnesium was observed in intercropped maize treated with pendimethalin plus two hand weeding at 3 and 6 WAS (016 mg/100g), followed by sole maize plot treated with pendimethalin plus two hand weeding at 3 WAS (01.5 mg/100g), while the lowest value was observed in the intercropped weedy check (0.10 mg/100g). In both cropping systems, there is no significant difference between the plot treated with pendimethalin alone and weedy check.

Iron (Fe)

The iron content ranged from 0.39 to 1.44 mg/100g (Table 2). The sole plot treated with pendimethalin

plus two hand weeding at 3 and 6 WAS (1.44 mg/100g) registered highest Fe content and the lowest was recorded in weedy check (0.39 and 0.42 mg/100g) of both cropping systems. Pendimethalin plus one hand weeding in cropping system showed no significant difference as shown in Table 1.

Copper (Cu)

The concentration of copper detected in maize grains was found to range from 0.03 to 0.05 mg/100 (Table 1). The highest was observed in sole plot treated with pendimethalin plus two hand weeding at 3 and 6 WAS (0.05 mg/100g), followed by pendimethalin plus one hand weeding (0.05 mg/100g), while the lowest was recorded in weedy check for both cropping systems

Zinc (Zn)

The concentration of zinc was significantly affected by weed control methods and it ranges from 0.61 to 0.68 mg/100g (Table 1). The highest is recorded in sole plot treated with pendimethalin plus two hand weeding at 3 and 6 WAS (0.68 mg/100g), which is statistically similar to the value obtained in pendimethalin plus one hand at 3 WAS (0.67 mg/100g). The lowest was observed in weedy check of both cropping systems.

Phosphorus (P)

The phosphorus (P) value ranged from 0.63-1.03 mg/100g with the highest value recorded in sole maize plot treated with pendimethalin plus two hand weeding at 3 and 6 WAS (1.03 mg/100g), followed by pendimethalin plus one hand weeding at 3 WAS (0.91 mg/100g), which is statistically similar (0.91 mg/100g) to the value obtained in intercrop plot treated with pendimethalin plus one weeding (Table 1).

Nitrogen (N)

The nitrogen content of maize grains affected by weed control treatments is shown in Table 1. The total nitrogen of the maize grains ranged from 1.60 – 2.41 mg/100g in both cropping systems. A significantly higher value of nitrogen was observed in intercrop plot treated with pendimethalin plus two hand weeding at 3 and 6 WAS 2.41 mg/100g), followed by the same treatment in sole plot (0.68 mg/100g). The least value was recorded in weedy check for the two cropping systems.

Mineral analysis of cowpea

Calcium (Ca)

The effects of pendimethalin and supplementary hand weeding on elemental analysis of harvested cowpea grains in mg/100g is presented in Table 2. Calcium content in cowpea grains was significantly ($P \leq 0.05$) affected by different weed control management and it ranges from 14.60–29.94 mg/100g. The maximum value was observed sole plot treated with pendimethalin plus two hand weeding at 3 and 6 WAS, was followed by intercrop plot treated with pendimethalin plus two hand weeding at 3 and 6 WAS.

The lowest calcium concentration was observed in the weedy check of the intercrop plot.

Magnesium (Mg)

Table 2 showed that magnesium concentration was significantly affected by different weed control practices. The range fell between 26.32 – 35.00 mg/100g in both cropping systems. The highest value was observed in sole plot treated with pendimethalin plus two hand weeding at 3 and 6 WAS (35.00 mg/100g), which showed statistical similarity with same treatment in intercropping system (33.70 mg/100g). The least were obtained in weedy check of both cropping system (26.32 and 26.80 mg/100g), which are statistically similar (Table 2).

Table 2: Effect of pendimethalin and hand weeding on mineral composition of cowpea

Treatment	Calcium	Magnesium	Potassium	Sodium	Manganese	Iron	Copper	Zinc	Phosphorus	Nitrogen
T1=(C+H)	20.89 ^d ±0.98	28.75 ^c ±0.94	182.23 ^d ±2.25	50.61 ^b ±1.38	0.34 ^b ±0.02	1.32 ^a ±0.03	0.11 ^c ±0.00	0.76 ^{cd} ±0.01	1.61 ^e ±0.04	3.22 ^e ±0.07
T2=(C+H+h)	22.05 ^e ±0.73	31.16 ^b ±0.02	186.46 ^c ±1.04	50.66 ^b ±1.42	0.36 ^a ±0.01	1.41 ^a ±0.03	0.12 ^b ±0.00	0.83 ^b ±0.04	3.00 ^c ±0.04	3.64 ^{cd} ±0.12
T3=(C+H+2h)	29.94 ^a ±0.14	35.00 ^a ±0.24	193.12 ^b ±0.78	54.98 ^a ±1.43	0.37 ^a ±0.01	1.40 ^a ±0.02	0.13 ^a ±0.00	0.90 ^a ±0.01	3.48 ^a ±0.02	3.97 ^a ±0.03
T4=(C+Wd)	16.50 ^f ±0.34	26.64 ^d ±1.05	176.75 ^e ±0.70	39.52 ^d ±0.65	0.27 ^d ±0.02	1.23 ^{ab} ±0.05	0.09 ^f ±0.01	0.69 ^e ±0.01	1.46 ^f ±0.01	3.12 ^e ±0.04
T5=C(l+H)	19.42 ^e ±0.33	26.80 ^d ±1.31	170.88 ^f ±4.80	43.69 ^c ±0.27	0.28 ^d ±0.01	1.11 ^b ±0.28	0.10 ^e ±0.00	0.68 ^e ±0.01	2.17 ^d ±0.03	3.52 ^d ±0.06
T6=C(l+H+h)	20.97 ^d ±0.58	28.36 ^c ±1.05	192.98 ^b ±0.98	49.73 ^b ±0.59	0.30 ^c ±0.02	1.33 ^a ±0.03	0.10 ^{de} ±0.00	0.76 ^d ±0.01	3.19 ^b ±0.06	3.74 ^{bc} ±0.14
T7=C(l+H+2h)	27.80 ^b ±0.61	33.70 ^a ±0.51	203.44 ^a ±0.76	51.15 ^b ±0.58	0.33 ^b ±0.01	1.41 ^a ±0.03	0.11 ^{cd} ±0.00	0.80 ^{bc} ±0.03	3.45 ^a ±0.01	3.84 ^{ab} ±0.15
T8=C(l+Wd)	14.60 ^g ±0.06	26.32 ^d ±0.89	166.36 ^g ±0.68	40.52 ^d ±0.31	0.30 ^c ±0.01	1.27 ^{ab} ±0.04	0.06 ^g ±0.00	0.64 ^f ±0.03	1.42 ^f ±0.02	2.45 ^f ±0.14
Total	21.52±4.98	29.59±3.27	184.03±12.03	47.61±5.42	0.32±0.04	1.31±0.13	0.10±0.02	0.76±0.08	2.47±0.86	3.44±0.48

Potassium (K)

The most abundant element was potassium and was significantly higher than all other elements analyzed. The value of potassium concentration ranged from 166.36 – 203.44 mg/100g (Table 2). All the weed control treatments recorded higher potassium content than the weedy check with highest value observed in intercrop plot treated with pendimethalin plus two hand weeding at 3 and 6 WAS (203.44 mg/100g) and the lowest was observed in the intercrop weedy check (166.36 mg/100g). Sole plot treated with pendimethalin plus two hand weeding at 3 and 6 WAS (193.12 mg/100g) and intercrop plot treated with pendimethalin plus one hand weeding (192.98 mg/100g) were statistically similar to each other.

Sodium (Na)

Table 2 shows the effect of different weed control methods on the sodium content of harvested cowpea

grains. Sodium content was found to range from 39.52 - 54.98 mg/100g in both cropping systems. The highest value was obtained in sole plot treated with pendimethalin plus two hand weeding at 3 and 6 WAS (54.98 mg/100g). The least value was recorded in the weedy check for both sole (39.52 mg/100g) and intercrop (40.92 mg/100g), which showed no significant different.

Manganese (Mn)

The concentration of manganese (Mn) in harvested cowpea grains ranged from 0.27 - 0.37 mg/100g. The highest was observed in plot treated with pendimethalin plus two supplementary hand weeding at 3 and 6 WAS (0.37 mg/100g) which shows no statistical variation with sole plot treated with pendimethalin plus one hand weeding at 3 WAS (0.36 mg/100g). In sole cropping system, the weedy check recorded the least (0.27 mg/100g) which is statistically similar to intercrop plot treated with pendimethalin alone (0.28 mg/100g).

Iron (Fe)

A significant effect was observed in all weed control methods compared to weedy check. Iron contents ranged from 1.11 to 1.41 mg/100g. Table 2 showed that the sole plot treated with pendimethalin plus two supplementary hand weeding at 3 and 6 WAS (1.45 mg/100g) recorded the highest Fe content (1.41 mg/100g), which showed statistical similarity with sole plots treated with pendimethalin alone and pendimethalin plus one hand weeding at 3 WAS. The lowest Fe content was recorded in intercrop plot treated with pendimethalin alone.

Copper (Cu)

The concentration (mg/100g) of copper in cowpea grains as affected by different weed control methods is as presented in Table 2. In the elemental analysis carried out on cowpea grains, copper was found to be the least of elements detected. The range fell between 0.06 to 0.13 mg/100g. The plot treated with pendimethalin plus two hand weeding at 3 and 6 WAS have relatively higher copper content compared to other treatments. The lowest content was observed in intercrop weedy check.

Zinc (Zn)

The concentration of zinc was significantly affected due to weed control methods. The concentration of zinc ranged from 0.64 to 0.90 mg/100g in both cropping systems. Significantly highest value was recorded in the sole plot treated with pendimethalin plus two hand weeding at 3 and 6 WAS (0.90 mg/100g) followed by sole pendimethalin plus one hand weeding at 3 WAS (0.83 mg/100g) and intercrop weedy check (0.64 mg/100g) recorded the lowest value.

Phosphorus (P)

The phosphorus (P) concentration ranged from 1.42 –3.48 mg/100g. The sole plots treated with pendimethalin plus two hand weeding recorded the highest value (3.48 mg/100g) showed value that was statistically at par with other weed control methods (Table 2). In the intercrop, significantly highest phosphorus content was observed in plot treated with pendimethalin plus two supplementary hand weeding at 3 and 6 WAS (3.73 mg/100g) which was statistically at par with the same treatment in the intercropping system. The least value was recorded in weedy check of the intercropping system.

Nitrogen (N)

The nitrogen content of harvested cowpea grains was affected by different weed control methods as presented in Table 2. Total nitrogen content of the grains ranged from 2.45 – 3.97 mg/100g and significantly highest nitrogen content was observed in sole plot treated with pendimethalin plus two hand weeding at 3 and 6 WAS (3.97 mg/100g). The lowest value of nitrogen was observed in intercrop weedy check (2.45 mg/100g).

Discussion

Mineral composition of maize

The concentrations of calcium, iron and zinc in this study agree with those reported by Hassan *et al.*, (2009), while the concentrations of potassium and sodium were found to be higher than that reported by Hassan *et al.* (2009), but lower than that of Feil *et al.* (2005), Hussaini *et al.* (2008) and Ullah *et al.* (2010). The concentration of magnesium found in this study is contrary to those reported by Hassan *et al.* 2009 and Feil *et al.* (2005). The low concentration of copper recorded in this work disagrees with the findings of Feil *et al.* (2005) and Ullah *et al.* (2010), who reported higher concentration. Similarly, Hussaini *et al.* (2008), reported that application of Nitrogen fertilizer up to 60kg/ha significantly increased the concentration of these major elements (nitrogen, phosphorous, magnesium and potassium). The amount of nitrogen recorded in this work is an indication that the variety used contain a high quantity of protein. Hence, the variation in the concentration of these elements in comparison with other studies could be due to varietal difference, genetic constituents, agronomic practices as well as fertilizer application during cultivation (Feil *et al.*, 2005). In all mineral elements investigated, potassium, magnesium and calcium were found to be higher than other elements in that order and concentration of copper was the least abundant. This could be attributed to its intercrop with leguminous crop, which has been found to be source of utilizable K, Mg, and Ca (Awodun *et al.*, 2007).

Mineral composition of cowpea

The concentrations of iron, zinc, and calcium reported in this study agree with the concentration reported by Owolabi *et al.*, (2012), but lower than those reported by Alayande *et al.*, (2012). The concentrations of calcium, magnesium, sodium in this study is higher than those reported by Arawande and Borokini, (2010). The concentrations of copper, iron, and potassium found in this study are lower than those reported by Alayande *et al.*, (2012), while

phosphorus is lower than that reported by Otitoju *et al.*, (2015). The concentrations of zinc and iron agree with those reported by Owolabi *et al.*, (2012), but lower than Olaleke *et al.*, (2006); Alayande *et al.*, (2012), and Otitoju *et al.*, (2015). The potassium content was found to be highest which was also found to be highest in the study carried out by Uduak (2018), on the mineral composition of two varieties of cowpea. The variation in the mineral composition in this study compared to other studies could be due to agronomical practices, soil compositions, and varietal differences (Darch *et al.*, 2020; Tasie and Gebreyes, 2020).

Conclusion

Based on the mean of two years result, it can be concluded that, the combined use of pendimethalin with two supplementary hand weeding, effectively controlled weed and significantly increased the mineral composition of the crops.

Competing interests

The authors declare that they have no competing interests

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