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ALLELOPATHIC EFFECTS OF AQUEOUS EXTRACTS OF SELECTED DOMINANT WEEDS ON WEED EMERGENCE, GROWTH, AND YIELD OF CUCUMBER (*CUCUMIS SATIVUS* L.) IN NSUKKA, NIGERIA

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Abstract

Allelopathy is increasingly investigated as a sustainable strategy to suppress weeds and reduce reliance on synthetic herbicides in cropping systems. This study evaluated the allelopathic effects of aqueous extracts from selected dominant weed species on cucumber (*Cucumis sativus* L.) seed and weed emergence, growth, and yield in the field. A field experiment was conducted in 2024 at the Teaching and Research Farm of the Department of Crop Science, University of Nigeria, Nsukka, located in the derived savanna agro-ecology of Southeastern Nigeria. The aqueous extracts of plant species such as *Ageratum conyzoides* (goat weed), *Helianthus annus* (wild sunflower), and *Amaranthus spinosus* (pig weed) were used singly and in combination along with a synthetic herbicide and an untreated control plot. The experiment was a randomized complete block design (RCBD) with three replications. The treatments included: Control (Water), Pigweed (PW) extract, Goat weed (GW) extract, Wild sunflower (WSF) extract, wild sunflower + Pigweed (WSF + PW) extract, pigweed + Goat weed (GW + PW) extract, Goat weed + Wild sunflower (GW + WSF) extract, and Synthetic herbicide (Sethoxydim applied at 1.5 kg a.i/ha) (SYNTH). Results showed that the weed control treatments gave a longer days before the emergence of weeds in each plot which ranged from 11.0 -10.33 days while the control took shorter number of days before weed emergence (8.67 days). The control plots recorded the highest infestation of *Mimosa pudica* (165.70 number/0.5m^2) and yellow nutsedge (*Cyperus rotundus*) (77.70 number/0.5m^2) when compared with other weed

Keywords: Allelopathy, Seed emergence, Aqueous weed extract, Dominant weeds, Phytotoxicity.

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control methods, while WSF extract recorded the lowest values. Plots treated with Wild sunflower (14.17 cm) and synthetic herbicides (13.40 cm) showed better vine length at 2 WAP (Weeks after planting), while plots treated with wild sunflower (100.20 cm) and the combination of goat weed and pigweed (76.90 cm) showed greater vine length at 6 WAP. These inhibitory effects align with findings that aqueous weed extracts can suppress germination and early growth in target plants by interfering with physiological processes. Our findings highlight the potential of locally abundant weed species in Nsukka as sources of bioherbicidal compounds for integrated weed management in cucumber production. Further research should isolate specific allelochemicals and evaluate field-level efficacy and crop safety..

Introduction

Cucumber (*Cucumis sativus* L.) is a popular vegetable crop in the *Cucurbitaceae* family. It is widely used for food, medicine, and in industry for production of cosmetic products (Devi & Pugalendhi, 2022). Cucumber faces several production constraints, including competition from weed populations, which reduces crop yield. Weeds remain one of the most persistent constraints to vegetable production worldwide, reducing crop yields by competing for light, nutrients, water, and space (Galkal et al., 2025). Chemical herbicides have been widely used to control weed populations, but their extensive application raises environmental and health concerns and can lead to resistance development in weed communities. As an alternative, allelopathy has gained considerable research interest as an eco-friendly weed management tool.

Amid increasing global challenges such as climate change, biodiversity loss, and rising food insecurity, there is an urgent need to adopt and expand more sustainable farming practices. One promising approach is allelopathy, a biological phenomenon in which plants release natural chemicals into the environment to suppress weed and pest growth. According to (Khamare and Marble, 2023), allelopathy is defined as a phenomenon in which plants release bio-chemicals known as allelochemicals that influence the growth and development of surrounding plants. These bioactive compounds are released into the environment through various pathways such as root exudation, volatilization, leaching, and residue decomposition, where they affect seed germination, plant growth, and physiological processes of neighbouring species. This eco-friendly method of weed and pest management reduces reliance on chemical herbicides and supports the principles of sustainable agriculture (Xuan et al., 2025).

Allelochemicals are secondary metabolites (such as phenolics, flavonoids, and terpenoids). These compounds exert phytotoxic effects on neighboring plants by disrupting fundamental physiological processes including gibberellin synthesis, membrane integrity, photosynthesis, and cell division. Recent studies show that aqueous extracts of plant species can inhibit seed germination and seedling development in crops and weeds alike (Taupik et al., 2022; Fatonah & Safitri, 2024), underpinning their potential use as botanical bioherbicides.

In cucurbits such as cucumber, allelopathic interactions are relevant because early seedling vigor is critical for crop establishment, and weeds emerging simultaneously can significantly suppress

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crop growth. Despite global research on allelopathy, a gap remains in documented allelopathic influences of dominant weed species on cucumber in the agroecological context of South-Eastern Nigeria. Nsukka, in particular, supports a diverse weed flora that may harbor potent allelochemicals capable of suppressing weed emergence or affecting crop growth. Understanding these interactions could inform the development of locally derived bioherbicidal options for smallholder farmers. This study therefore aimed to evaluate the allelopathic effects of aqueous extracts of selected common weeds on weed emergence, growth, and yield of cucumber and to assess their potential as botanical bioherbicides for integrated weed management in Nsukka's agroecosystems.

Description of the study area

The field experiment was conducted during the 2024 planting season at the Teaching and Research Farm of the Department of Crop Science, University of Nigeria, Nsukka. The research farm lies at Latitude 06° 51' N and Longitude 07° 23' E at an altitude of 427 m above sea level. Nsukka belongs to the tropical savanna (wet and dry) climate according to the Koppen-Gieger climate classification scheme (Onyenucheya and Nnamchi, 2018), with predominantly sandy clay and loamy sand soil types (kayode et al., 2019). the climate is humid tropical; mean annual rainfall of 1600 mm that is bimodal rainfall distributed with peaks in July and October, evapotranspiration of 1560 mm, minimum and maximum temperatures of 21 and 31 0C respectively and relative humidity in the range of 69-79%.

Experimental Design

This study used a single-factor randomized complete block design (RCBD). Treatment in the form of an extract concentration of *Ageratum conyzoides* (goat weed), *Amaranthus spinosus* (Pig weed) and *Helianthus annuus* (Wild Sunflower) (3 treatments) compared to mixture of extracts (3 treatments), application of synthetic herbicide, and water as control which are represented thus: Control (Water), Pigweed (PW), Goat weed (GW), Wild sunflower (WSF), wild sunflower + Pigweed (WSF + PW), pigweed + Goat weed (GW + PW), Goat weed + Wild sunflower (GW + WSF) and Synthetic herbicide (Sethoxydim applied at 1.5 kg a.i/ha) (SYNTH). Each treatment is repeated three times.

Preparation of extracts, planting of seeds and treatment of extracts

Extract preparation was carried out as follows: Leaves from the different plants were collected within the University environs, washed with clean water, and dried in a shed in the Crop Science Teaching Laboratory. Once completely dried, they were ground into a powder using an industrial blender. For the sole application, 20 g of powder from each leaf was mixed with 2 liters of distilled water; for the mixed extracts, 10 g of powder from each leaf was mixed with 2 liters of distilled water and used for each application. Applications were made at two-week intervals until harvest.
The experimental field was cleared, thoroughly ploughed and harrowed using a tractor. To further refine the soil tilth, seedbeds were manually prepared with a hoe before laying out the experimental field. The required area of land (19.5 m x 6.5 m (126.75 m^2) was marked out, split into blocks, and subdivided into eight treatment plots per block to give 24 plots in all, each measuring

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2 m by 1.5 m (3 m^2). A 1-m pathway was maintained between blocks, and a 0.5-m distance was maintained between treatment plots within a block. Staking was done for easy climbing of the cucumber vines.

Cucumber seeds (Var. Poinsett) were purchased from Jubaili Seed Company and sown at three per hole after drilling to a shallow depth of about 1.5-2 cm. Plant holes were drilled at pre-marked points according to the plant spacing. The plant spacing was 0.75 m by 0.5 m, giving a total of 9 plants per plot. Seedlings were later thinned down to one per stand two weeks after emergence. Poultry manure was added as a blanket application at the rate of ten tonnes per hectare before bed formation. Fruits were harvested at maturity.

Data collection and analysis

Agronomic data were collected on two randomly selected and tagged middle-row plants per plot. The same data were also collected from the remaining plants in the plot. The weed data were collected using a 0.5 m^2 quadrat.

Vegetative growth characteristics

Observations on the vegetative growth of cucumber were done at 4, 6, 8, and 10 weeks after planting (WAP). Data collected were vine length, leaf diameter, vine circumference per plant, and number of branches per plant. Vine length was measured using a measuring tape from the soil surface to the plant's terminal end. Leaf diameter was measured using a measuring tape, and vine circumference was obtained by using a rope around the vine at the tip, center, and base, and the average was taken. Number of branches was counted per sampled plant.

Reproductive fruiting and yield data

We recorded days to first flowering per plot, number of flowers per plant, days to first fruit emergence, number of fruits per plant, fruit length per plot, fruit circumference, and fruit weight per plot.

Weed data

Weed identification: Weeds encountered in the different plots were identified to species level using a handbook of West African weeds (Akobundu et al., 2016).

Days to first weed emergence: This was recorded per plot by observing from the first day of spraying the aqueous extract to the first day weeds appeared.

Number of weeds and types of weeds: This was done by recording the number and types of weeds per plot and by counting and observing each weed type in each plot from the first day of spraying until two weeks after planting. The weed data were taken using a 0.5 m^2 quadrat.

Data analysis

Data were subjected to one-way analysis of variance by the procedure appropriate for RCBD experiments using the software GenStat Release 18.0 Discovery Edition. Differences were determined at the 5% probability level ($p < 0.05$), and the means were separated using Fisher's Least Significant Difference ($LSD_{0.05}$).

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Results and discussion

Table 1 shows the phytochemical contents of the botanicals. *H.annuus* gave higher alkaloid content (8 mg/100 g), while *A. conyzoides*, and *A. spinosus* recorded 6 mg/100 g each. *A.conyzoides* recorded higher flavonoid and phenol contents (7.0 and 64.47 mg/100g respectively, while the least for these contents were recorded by *A. spinosus*. *A.conyzoides* and *A. spinosus* recorded similar values for saponin, tannin, and glycoside (1.0, 3.0, and 3.90 mg/100 g), respectively, while *H. annuus* recorded 0.0, 2.08 and 2.20 mg/100 g) for these parameters. *A. spinosus* recorded higher terpenoid content (53.80 mg/100 g), which is followed closely by H. annuus (52.15 mg/100 g), while the least was recorded by *A. conyzoides* (37.33 mg/100 g).

Table 1: Phytochemical contents of goat weed (*Ageratum conyzoides*), Spiny pigweed (*Amaranthus spinosus),* and wild sunflower *(Helianthus annus)*

Phytochemicals	Goat weed (mg/100 g)	Pig Weed (mg/100 g)	Wild sunflower (mg/100 g)
Alkaloid	6.00	6.00	8.00
Flavoniod	7.00	2.00	5.00
Saponin	1.00	1.00	0.00
Tanin	3.00	3.00	2.08
Glycoside	3.90	3.90	2.20
Phenol	64.47	45.07	32.81
Terpenoid	37.33	53.80	52.15

Infested weed species in the experimental field

The study identified ten (10) weed species belonging to eight (8) families (Table 2). The weed species included 6 broadleaf species, 3 grasses, and 1 sedge. Poaceae had 3 species, while other families, including *Fabaceae*, Asteraceae, *Rubiaceae*, *Cleomaceae*, *Cyperaceae*, and *Nyctaginaceae*, had one species each. Among the weed control practices, the control plots recorded higher weed species diversity, while the plot with synthetic herbicide application recorded the lowest. The most abundant broadleaf weeds across treatments were *Mimosa invisa*, *Ageratum conyzoides, and Amaranthus retroflexus*. The most abundant grass weed species were *Echinochloa crus-galli* and *Cynodon dactylon*. *Cyperus rotundus* was the only sedge recorded, although, very abundant. These different weed types have been reported to be associated with cucumber (Khasan, 2026).

Table 2: Weed species observed in the experimental plots and their preponderance

Common name	Scientific name	Family	Lifecycle	Morphology	Weed severity
Giant sensitive plant	*Mimosa invisa*	*Fabaceae*	Annual	Broadleaf	***
Billygoat weed	*Ageratum conyzoides*	*Asteraceae*	Annual	Broadleaf	***
Gooosegrass	*Eleusine indica*	*Poaceae*	Annual	Grass	*
Barnyard grass	*Echinochloa crus-galli*	*Poaceae*	Annual	Grass	***
Bermuda grass	*Cynodon dactylon*	*Poaceae*	Annual	Grass	**
Tropical girdlepod	*Mitracarpus villosus*	*Rubiaceae*	Annual	Broadleaf	*
Redroot pigweed	*Amaranthus retroflexus*	*Amarantheceae*	Annual	Broadleaf	***
Tick weed	*Cleome viscosa*	*Cleomaceae*	Annual	Broadleaf	**
Red spiderling	*Boerhavia erecta*	*Nyctaginaceae*	Annual	Broadleaf	*
Purple nutsedge	*Cyperus rotundus*	*Cyperaceae*	Perennial	Sedge	***

*Less Severe, ** Severe, *** Most Severe

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Effects of the botanical extracts on types and number of weeds

Some dominant weeds that emerged from the plots were studied. From Table 3, it was observed that the use of pig weed extract alone, goat weed extract alone, and application of synthetic herbicide gave significantly ($p<0.05$) higher values (11.33, 11.33, and 11.0 days) for days to first weed emergence, while the control gave the lowest value (8.67 days). The number of weeds that emerged per plot was also studied; the control recorded a significantly ($p<0.05$) higher number of weeds (274.40 number/0.5m^2), while the plots treated with WSF gave the lowest mean value (120.70 number/0.5m^2).

In the same vein, the control gave a significantly ($p<0.05$) higher number of Mimosa pudica that emerged (165.70), while the use of WSF recorded the lowest value (95.7). Although not significant ($p>0.05$), the control had the highest number of goat weed that emerged (31.00), while the synthetic herbicide plot had the lowest value (4.70). The control had a significantly higher number of nutsedge that emerged (77.70) than WSF + PW (55.0), GW + PW (43.3), and GW alone (43.7), while the lowest was in plots treated with wild sunflower extract alone (17.30).

The results showed the extracts' effectiveness in inhibiting germination in dominant weeds such as *Mimosa* invisa, *Ageratum* conyzoides, and *Cyperus* rotundus, as shown by the number of days to emergence and the number of weeds that emerged. The extract alone reduced the weed population when compared with the mixtures. The number of nutsedge (Cyperus rotundus) that emerged also decreased, especially with wild sunflower extract alone, indicating its inhibitory effect on C. *rotundus* emergence. The extracts inhibited weed germination due to their allelochemical content, which delayed germination. The seeds were still alive but germinated more slowly because allelochemicals inhibit germination processes, including hydrolysis of food reserves, respiration, and embryo growth. This is related to the effect of allelochemicals in inhibiting water absorption, cell elongation, cell division, respiration, enzyme activity and function, phytohormone metabolism, and gene expression (Bachheti et al., 2020; Fatonah & Safitri, 2024)

Table 3: Effects of some botanical extracts on types and number of weeds that emerged in cucumber field

TREATMENTS	DFWE (days)	TNWE (Number/0.5m^2)	NMPE (Number/0.5m^2)	NGWE (Number/0.5m^2)	NNSE (Number/0.5m^2)
Control	8.67	274.4	165.70	31.00	77.70
Pig weed extract (PW)	11.33	194.40	155.30	17.10	22.00
Goat weed extract (GW)	11.33	174.50	123.70	7.10	43.70
Wild sunflower extract (WSF)	10.00	120.70	95.70	7.70	17.30
WSF+PW	10.33	202.70	132.00	15.70	55.00
GW+PW	10.33	200.30	143.30	13.70	43.30
GW+WSF	10.33	167.40	135.30	6.40	25.70
SYNTH	11.00	158.30	131.30	4.70	22.30
F-LSD (0.05)	1.87	64.52	50.80	NS	34.28

Where DFWE = Days to first weed emergence, TNWE = Total number of weed that emerged per plot, NMPE = Number of *Mimosa invisa* that emerged, NGWE = Number of Goat weed that emerged, NNSE = Number of nutsedge that emerged, WSF+PW = wild sunflower + pig weed, GW+PW = Goat weed + pig weed, GW+WSF = Goat weed + wild sunflower, SYNTH = synthetic herbicide (Sethoxydim applied at 1.5 kg a.i/ha), F-LSD = Fisher's Least Significant Difference at 5% level of probability.

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Effects of some botanical extracts on cucumber growth parameters

Table 4 shows the effect of the weed extracts on cucumber growth parameters. At 2 WAP, it was observed that the use of WSF recorded significantly ($p<0.05$) higher vine length (14.17cm), which is statistically similar to those plots treated with synthethic herbicide (13.40 cm), GW+ WSF (12.80 cm), WSF+PW (12.23 cm), PW (11.57 cm) and Control (10.82 cm) while the least vine length was recorded by plots treated with GW+PW (8.0 cm).

It was also recorded that the use of synthetic herbicide gave a non-significantly ($p>0.05$) higher value (0.46cm) for vine circumference; the use of GW+PW gave the lowest value (0.28cm). In the same vein, the use of synthetic herbicide recorded a non-significantly ($p>0.05$) higher value (3.13) for number of branches (NB), while the use of PW recorded the lowest value (2.39). For leaf diameter, GW+PW gave a significantly ($p<0.05$) higher value (6.20cm), while GW+WSF gave the lowest value (2.95cm) after 2 weeks. At 4 WAP, wild sunflower gave significantly higher vine length (54.10 cm) ($p < 0.05$), similar to plots treated with goat weed + wild sunflower (49.90 cm) and comparable to other treatments. In contrast, plots treated with pig weed had the lowest vine length (26.0 cm), which did not differ significantly from the control (28.10 cm) or synthetic herbicide (28.00 cm). Wild sunflower (7.12 cm) and goat weed + pig weed (7.20 cm) produced significantly thicker vines than the control (2.30 cm) ($p < 0.05$). The plots treated with GW produced a significantly ($p<0.05$) higher number of branches (5.17), which was statistically similar to those of SYNTH (5.0), GW+WSF (4.50), GW + PW (4.92), WSF + PW (4.50), and WSF (4.67), while the least was recorded by the control (3.80).

At 6 WAP, wild sunflower (100.20 cm), goat weed + pig weed (76.90 cm), and pig weed (56.00 cm) produced ($p<0.05$) longer vines than the control (30.70 cm), while vine circumference, number of branches, and leaf diameter did not differ significantly ($P > 0.05$).

The synthetic herbicide did not differ significantly from the control in any parameter. No extract significantly reduced growth, indicating a stimulatory rather than inhibitory effect on cucumber vegetative growth**.** This demonstrates an allelopathic hormetic response. The extracts may have acted as biostimulants rather than phytotoxins. This growth enhancement was further driven by the dual action of co-extracted plant nutrients and endogenous growth regulators within the weed tissues, which collectively overrode potential inhibitory pathways and optimized the physiological development of the receiver cucumber plants. Although several studies showed inhibitory effects of aqueous extract on plant growth, the results showed the opposite. This may be because the applied dosage was not high enough to cause an inhibitory effect. This aligns with Bakhshayesnan-Agdam et al. (2015), who reported that cucumber was more resistant to a low concentration of aqueous redroot pigweed extract than to a high concentration.

Table 4: Effects of some botanical extracts on cucumber growth parameters over the study period.

TREATMENT	Vine length (cm)	Vine circumference (cm)	Number of branches	Leaf diameter (cm)
2 Weeks after planting				
Control	10.82	0.37	3.00	3.27
Pig weed extract (PW)	11.57	0.33	2.42	4.08
Goat weed extract (GW)	10.68	0.33	2.50	4.47

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TREATMENT	Vine length (cm)	Vine circumference (cm)	Number of branches	Leaf diameter (cm)
Wild sunflower extract (WSF)	14.17	0.43	2.53	4.10
WSF+PW	12.23	0.40	2.58	2.87
GW+PW	8.00	0.28	2.39	6.20
GW+WSF	12.80	0.37	2.92	2.95
SYNTH	13.40	0.46	3.13	3.65
F-LSD (0.05)	**3.35**	**NS**	**NS**	**3.23**
4 Weeks after planting				
Control	28.10	2.30	3.80	10.53
Pig weed extract (PW)	26.00	4.40	4.25	9.62
Goat weed extract (GW)	35.70	2.23	5.17	9.67
Wild sunflower extract (WSF)	54.10	7.12	4.67	9.43
WSF+PW	33.60	3.73	4.50	9.60
GW+PW	36.00	7.20	4.92	9.13
GW+WSF	49.90	6.10	4.50	11.37
SYNTH	28.00	2.40	5.00	10.63
F-LSD (0.05)	**17.36**	**4.22**	**1.33**	**NS**
6 Weeks After Planting				
Control	30.70	2.60	6.08	11.44
Pig weed extract (PW)	56.00	2.77	6.42	10.27
Goat weed extract (GW)	34.90	2.61	6.42	11.04
Wild sunflower extract (WSF)	100.20	3.00	6.00	10.23
WSF+PW	32.80	2.67	6.00	10.47
GW+PW	76.90	3.00	6.42	10.73
GW+WSF	37.50	2.73	5.83	12.23
SYNTH	32.00	2.88	5.92	11.67
F-LSD (0.05)	**17.89**	**NS**	**NS**	**NS**

Where VL = vine length, VC = vine circumference, NB = number of branches, LD = leaf diameter, WSF+PW = wild sunflower + pig weed, GW+PW = Goat weed + pig weed, GW+WSF = Goat weed + wild sunflower, SYNTH = synthetic herbicide (Sethoxydim applied at 1.5 kg a.i/ha), F-LSD = Fisher's Least Significant Difference at 5% level of probability.

Effects of some botanical weed extracts on cucumber yield

Table 5 shows the effect of the weed extracts on cucumber yield parameters. All the weed control practices significantly affected days to flower emergence, days to fruit emergence, number of flowers that emerged, and average fruit circumference. Plots treated with PW took fewer days for flowers to emerge (46.33 days), followed closely by WSF+PW (48.33 days), while GW+PW took more days (52.33 days). WSF took a longer number of days for fruit to emerge (64.0 days), which is statistically ($p<0.05$) similar to those of the plots treated with GW+PW (63.33 days), Control (62.67 days), and Synth (60.33 days), while the least number of days (58.0 days) was recorded by WSF + PW and GW alone, respectively. Control and plots treated with GW+PW recorded a significantly ($p<0.05$) higher number of flowers (5.67), which was closely followed by plots treated with GW (5.58), WSF (5.50), and SYNTH (5.58), while the lowest value (4.44) was recorded by the plot treated with GW+WSF. PW recorded a significantly ($p<0.05$) higher average fruit

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circumference (17.76 cm), while the lowest was recorded by SYNTH (15.39 cm). Although the number of fruits per plot, average fruit length per plot, and average fruit weight per plot did not differ significantly (P > 0.05), plots treated with PW recorded higher yield (273 g), while the lowest yield (240 g) was recorded by WSF+PW plots. This may be because reduced weed competition maintained adequate growth resources and better source-sink relations, which in turn enhanced photosynthate translocation from source to fruit, resulting in higher fruit yield. This aligns with Geethinka et al. (2022), who reported improved groundnut performance and yield with aqueous extract application.

Table 5: Effects of some botanical weed extracts on cucumber yield at 6 weeks after planting.

TREATMENT	DFL (days)	DFEM (days)	NFL	NFP	AFL (cm)	AFC (cm)	AFW(g)
CONTROL	51.67	62.67	5.67	14.33	18.23	15.97	270.00
Pig weed extract (PW)	46.33	59.33	5.33	9.00	19.29	17.96	273.00
Goat weed extract (GW)	49.00	58.00	5.58	9.00	18.80	15.37	269.00
Wild sunflower (WSF)	52.00	64.00	5.50	16.67	18.91	13.42	265.00
WSF+PW	48.33	58.00	4.50	10.00	18.00	16.30	240.00
GW+PW	52.33	63.33	5.67	13.33	20.63	15.51	241.00
GW+WSF	50.67	58.33	4.44	11.33	19.39	15.88	264.00
SYNTH	51.33	60.33	5.58	12.67	16.84	15.39	270.00
F-LSD (0.05)	**4.33**	**3.79**	**1.27**	**ns**	**ns**	**3.03**	**ns**

Where DFL = Days to flowering per plot, DFEM = Days to fruit emergence per plot, , NFL = Number of flowers per plot, NFP = Number of fruits per plot, AFL = Average fruit length per plot, AFC = Average fruit circumference per plot, AFW = Average fruit weight per plot, WSF+PW = wild sunflower + pig weed, GW+PW = Goat weed + pig weed, GW+WSF = Goat weed + wild sunflower, SYNTH = synthetic herbicide (Sethoxydim applied at 1.5 kg a.i/ha), F-LSD = Fisher's Least Significant Difference at 5% level of probability.

Conclusion and Recommendation

This field study showed that aqueous leaf extracts of *Ageratum conyzoides*, *Amaranthus spinosus* and *Helianthus annuus* have bioherbicidal potential in cucumber production in Nsukka. The extracts delayed weed emergence by about 1.3 to 2.7 days compared with the untreated control (8.67 days), and the gain was statistically significant for the pigweed, goat weed, and synthetic herbicide treatments. Wild sunflower extract applied alone was the most promising. It recorded the lowest counts of *Mimosa* (95.7 per 0.5 m^2) and purple nutsedge (17.3 per 0.5 m^2), and the lowest total weed count (120.7 per 0.5 m^2). Its nutsedge suppression was comparable to that of sethoxydim. Mixing extracts did not improve weed suppression, and single-species extracts generally performed as well as or better than their combinations.

No extract reduced cucumber growth. Wild sunflower extract, and to a lesser extent goat weed + pigweed and pigweed alone, increased vine length at 4 and 6 weeks after planting. This suggests a stimulatory (hormetic) response at the applied concentrations rather than phytotoxicity to the crop. However, the extracts did not significantly change fruit number, fruit length, or fruit weight.

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The improved weed suppression and early vine growth therefore did not translate into a demonstrable yield advantage over the control.

Overall, these locally abundant weeds can serve as low-cost, crop-safe sources of botanical weed suppressants within integrated weed management for smallholder cucumber systems. They are best regarded as a complement to, not a replacement for, synthetic herbicides. Future work should therefore test a range of concentrations across several seasons and sites. It should also assess weed biomass and season-long weed dynamics, and isolate and characterize the active allelochemicals, particularly those responsible for the suppression of *C. rotundus*, before recommending these extracts to farmers.

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