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Efficacy of spring onion (*Allium fistulosum*) leaf extract for controlling major field insect pests of cowpea (*Vigna unguiculata* L.) in the guinea savannah Agroecological zone of Ghana

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Abstract
The study was set up at University for Development Studies, Tamale, during the 2017 cropping season to assess the efficacy of spring onion extract for controlling major field insect pests of cowpea. The study was a single factor experiment, laid out in an RCBD with three replications. Treatments used were: T1= water, T2, T3, T4 and T5 were respectively made up of 5%, 10%, 15% and 20% of spring onion extract concentrations, T6= synthetic insecticide. Parameters measured were yield components, total yield, insect pest infestations. The highest grain yield was recorded by synthetic insecticide (3367 kg/ha), followed by 20% and 15% concentrations of spring onion extract, 3037 and 2940 kg/ha respectively. Treatment with water recorded the highest grain yield loss (76.15 %) followed by 5%, 10%, 15% and 20% concentrations of spring onion extract, recording yield losses of 67.83%, 21.80%, 12.68% and 1.10% respectively. This indicates that insect pests are economically important and their control is imperative for yield maximization and sustainable cowpea production.

Keywords: Spring onion, extract, concentration, pests, cowpea, yield loss

1. Introduction
Cowpea (*Vigna unguiculata* L.) remains the most popular leguminous crop with an African origin. Africa accounts for 91% of global cowpea production, 75% of Africa's production occurs in West Africa [1]. Cowpea an important and dependable crop that provides income for most people especially small-holder farmers and traders [2]. Total seed protein content ranges between 23% to 32% of seed weight [3]. Cowpea seed is also a rich source of minerals and vitamins, and among plants has one of the highest contents of folic acid and B-vitamin that prevent birth defects in the brain and spine during pregnancies [3].
Pests and diseases are major constraints to maximizing cowpea yield. Cowpea is highly susceptible to pests that limit its productivity by attacking and causing considerable damage, resulting in low yield and economic losses [4, 5]. Cowpea is particularly attractive to both field and storage insect pests; whose attack and damage limit its production and productivity [5]. Low cowpea yield (200-350 kg/ha) obtained by some cowpea farmers in the West African sub-region is directly attributed to field insect pests [6].
Resource poor farmers have utilized plant extracts for insect pest control in traditional agricultural systems. Studies have shown that extracts prepared from seeds, leaves, barks and roots of various plant species are effective in protecting crops against insect pest attacks. Most of these studies are however targeted at storage pests [7]. The potential use of plant extracts as biopesticides for field pest control is currently receiving a lot of research attention worldwide. Plant belonging to the family Alliaceae possess various biological properties. These plants contain exogenous and endogenous antioxidants such as selenium, glutathione, vitamins A, B, and C, and flavonoids such as quercetin and isorhamnetin [8]. These molecules confer some insecticidal, acaricidal, fungicidal, nematicidal and bactericidal properties in plants of this family [9]. Therefore, this study was carried out (1) to assess the efficacy of spring onion extract for controlling major field insect pests of cowpea (2) to identify the target insect pest most susceptible to spring onion extract.

2. Materials and Methods
2.1 Study area and experimental treatments
The study was conducted during the 2017 cropping season from July to October, at the

experimental field of the University for Development studies, Tamale, Ghana. It was a single factor experimental laid out in a Randomized Complete Block Design (RCBD) with three replications. Experimental units measured 5m x 4m with an alley of 1m and 2m between plots and replications respectively. Sangotra, a medium maturing cowpea variety widely cultivated by farmers in the study area was used.

The following treatments were used.

- **T1** Water
- **T2** 5% concentration (w/v) of aqueous spring onion leaves extract
- **T3** 10% concentration (w/v) of aqueous spring onion leaves extract
- **T4** 15% concentration (w/v) of aqueous spring onion leaves extract
- **T5** 20% concentration (w/v) of aqueous spring onion leaves extract
- **T6** synthetic insecticide (K-Optimal) @ 1L/ha

2.2 Preparation of spring onion extract and application of treatments

Extract was prepared according to the procedure described by [11] a day prior to each application.

According to [11] to prepare 5% concentration (w/v) of aqueous spring onion extract, approximately 600g of air-dried spring onion leaves are blended into fine powder. The powdered mass is then soaked in 15 litres of water. About 10g of "key soap" (a commercial detergent) is added to the content to help enhance the adhesiveness of the extract as was done by [12]. The content is stirred and allowed to stand overnight. The content is then stirred and sieved to obtain the extract.

To prepare 10%, 15% and 20% concentration (w/v) of the extract 1,200g, 1,800g and 2,400g respectively of air-dried spring onion leave is used through the same procedure to obtain the respective concentrations.

Spring onion extract and the control (water) were applied using a 15 litres capacity knapsack sprayer at 4th, 5th, 6th and 7th week after plant emergence. The synthetic insecticide (K-Optimal) treatment was applied at 4th and 6th week after emergence as prescribed by the manufacturer. Weeding was done manually by hoeing at the 3rd, 5th and 7th weeks after planting.

2.3 Data collection

Five inner rows of each experimental unit were used for data collection. Ten flowers were sampled in each experimental unit for records on the incidence of insect pests. Incidence of insect pests were recorded two days after each treatment application. Targeted insect pests were *Maruca vitrata* (Pod borer), *Aphid craccivora* (Aphids), *Megalurothrips sjostedti* (Thrips), *Anoplocnemis curvipes* (bug). Agronomic parameters measured were pod length, pod weight, 100 seed weight, biomass yield and grain yield.

2.4 Data analysis

Data collected were subjected to ANOVA using Genstat Statistical package, 12th edition. Means were separated using LSD at 5% level of significance. The synthetic insecticide treatment was used as a reference for yield loss calculation.

3. Results

3.1 Yield components

The treatments affected pod length, number of seeds per pod and 100 seed weight significantly (P<0.05). Synthetic insecticide (K-optimal) recorded the longest pods, highest number of seeds per pod and highest 100 seed weight, its performance was however similar to 20% and 15% spring onion extract concentrations (Table 1). These parameters decreased with a decrease in spring onion extract concentration. Plants sprayed with water recorded the lowest values for these parameters (Table 1).

Table 1: Yield components

Treatment	Panicle length (cm)	No. of seeds/pod	100 seed weight
Water	5.21c	5.67d	25.40c
5% a.i. conc.	5.69c	8.00c	31.10bc
10% a.i. conc.	6.47b	10.33b	34.40abc
15% a.i. conc.	6.83ab	11.67b	36.40ab
20% a.i. conc.	7.07ab	13.67a	39.70ab
K-optimal	7.46a	14.67a	44.40a
LSD (0.05)	0.70	1.52	9.73

Means followed by the same letter (s) in each column are not significantly different

3.2 Incidence of targeted insect pests

The treatments significantly (P<0.05) affected the population of targeted field insect pests of cowpea. Plots treated with K-optimal recorded the least population of targeted insect pests at peak sampling periods (Table 2). There was a resultant increase in population of targeted insect pests with a decrease in concentration of the active ingredient of spring onion extract, T5<T4<T3<T2, at peak sampling periods (Table 2).

The highest population of targeted insect pest was recorded in plots treated with water (Table 2). Mean population of Maruca, Aphids, Thrips and PSBs at peak sampling periods in spring onion extract treated plots were 12.33, 7, 8.66 and 15 respectively (Table 2). This indicated that Aphids were the most susceptible to the spring onion extract treatment, followed by Thrips, PSBs and Maruca respectively.

Table 2: Infestation by targeted field insect pests of cowpea

	Maruca	Aphids		Thrips		PSBs	
Treatment	larva/flower	4 WAE	5 WAE	5 WAE	6 WAE	6 WAE	7 WAE
Water	4.67a	3.00a	8.33a	4.67a	3.67a	7.00a	6.67a
K-optimal	1.33c	0.00	0.33c	0.67d	1.00d	1.33c	1.33e
5% a.i. conc.	4.33a	0.67b	3.67b	3.00b	3.00ab	6.00a	5.67b
10% a.i. conc.	3.00b	0.00	2.00bc	3.33b	2.33b	4.00b	4.33c
15% a.i. conc.	3.00b	0.00	1.00c	2.00c	2.00bc	3.33b	2.67d

20% a.i. conc.	2.00c	0.00	0.33c	1.33cd	1.33cd	2.00c	2.33d
Mean of SOEC	12.33	0.67	7.00	9.66	8.66	15.33	15.00
LSD (0.05)	0.79	1.03	2.25	0.88	0.79	1.18	0.94

Means followed by the same letter (s) in each column are not significantly different.
PSBs= Pod sucking bugs, WAE= weeks after emerge. SOEC=Spring Onion Extract Concentrations

3.3 Yield and yield loss

Biomass and grain yield were significantly (P<0.05) affected by the treatments. K-optimal recorded the highest fresh biomass weight, its performance was however similar to 20% concentration of spring onion extract (Table 3). These were followed by 15%, 10% and 5% concentration of spring onion extract (Table 3). K-optima and 20% concentration of spring onion extract recorded similar dry biomass yield as were 15%, 10% and 5% concentration of spring onion extract (Table 3).
The highest grain yield was recorded by K-optimal (Table 3). Its performance was however similar to 20% and 15% concentration of spring onion extract (Table 3). The least grain yield was recorded by 5% concentration of spring onion extract and treatment with water (Table 3). Percentage loss in grain yield increased with decreasing concentration of spring onion extract (Table 3). Treatment with water recorded the highest yield loss of 76.15%, followed by 5%. 10%, 15% and 20% concentrations of spring onion extract, which recorded yield losses of 67.83%, 21.80%. 12.68% and 0.10% respectively (Table 3).

Table 3: Yield and yield loss

Treatment	Fresh. Biomass Yield (kg/ha)	Dry Biomass Yield (kg/ha)	Grain yield (kg/ha)	% grain yield loss
Water	2409b	537c	803c	76.15
5% a.i. conc.	2479b	710bc	1113c	67.83
10% a.i. conc.	2553b	737bc	2633b	21.80
15% ad. conc.	2706b	764bc	2940ab	12.68
20% ad. conc.	3759a	1010ab	3037ab	0.10
K-optimal	4255a	1215a	3367a	
LSD (0.05)	735	306	478	

Means followed by the same letter (s) in each column are not significantly different

4. Discussion

The present study showed that the target insect pests are economically important in cowpea production in the study area. It confirms findings of [13, 14] who stated that the black cowpea aphid, *Aphis craccivora*, the cowpea flower thrips, *Megalurothrips sjostedti*, the legume pod borer, *Maruca vitrata* and a complex of pod-and seed-sucking bugs including *Anaplocnemis curvipes*, are among the most serious field insect pest species that infest cowpea in the study area [15]. Also reported that insect pests attack cowpea throughout its growth resulting in significant yield losses.
The study revealed that the incidence and damage by target insect pests were effectively reduced by spring onion extract resulting in an increase biomass and grain yield, efficacy of the extract against these pests increased with an increase in concentration of the extract. This is believed to have resulted from the potency of the active ingredient of spring onion extract to have exerted insecticidal actions against the target insect pests. This agrees with findings of [16] who obtained a significantly higher grain yield from cowpea treated with 20% neem seed extracts compared to the control [17]. also reported an increase in efficiency of aqueous neem extract and methanolic neem extract, at higher concentrations against *Heterona glycines* females and eggs on soybean cultivated under greenhouse (almost 90%) and *in vitro* J2 mortality (almost 100%). Findings of the current study also supports findings made by [8] in a related study, in which extracts of *Allium sativum* and *Allium fistulosum* proved toxic to be against *Callosobruchus maculatus* [3]. In a related study in cabbage stated that extracts of garlic and chili conferred resistance to major insect pests. Variation in susceptibility of the targeted insect pests of cowpea to spring onion extract is believed to be as a result of variation in biology and feeding behavior of these insects.

5. Conclusion

It can be concluded from the present study that insect pests are major constraint to yield maximization in cowpea production. Application of 20% and 15% spring onion extract concentrations increased yield components and grain yield similar to the synthetic insecticide. Yield losses due to insect pest infestation was greatly reduced by 20% and 15% spring onion extract concentrations. It was evident that yield loss could be as high as 76% in uncontrolled fields. Spring onion extract proved effective in controlling the target insect pests especially at higher concentrations to the limits used in this study. It can therefore be concluded that spring onion extract concentration of 20% and 15% could be effective substitutes for synthetic cowpea insecticides or may also be integrated with synthetic insecticide for sustainable cowpea production.

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