IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 16, Issue 10 Ser. I (October. 2023), PP 40-45
www.iosrjournals.org

Evaluation of Selected Green Gram (*Vigna Radiata*) Varieties Against Insect Pests Infestation in The Field, Tharaka Sub-County, Kenya

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Abstract

Background: *Green grams farming plays a vital role in Tharaka and the country(Kenya) at large by ensuring food security, creating employment for rural households and greatly contributing to the national economy. However, the infestation of pests on the green grams has drastically affected its production in the country. This paper presents different types of insect pests attacking green grams in the field and the most resistant among the selected green gram crop varieties in Tharaka sub-county of Kenya.*

Materials and Methods: *Insect pest infestation was monitored on the following green gram crop varieties; Uncle (KS20), Biashara (KAT 00308), Karembo (KAT 00309), Tosha (KAT 00301) and Nylon (N26). The level of resistance of the aforementioned green gram crop varieties against the field pests was also determined. The study was conducted in Mukothima and Gatunga wards of the Sub-County during one growing season (March-May, 2023), the period of long rains. The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications. The type and population of insect pest was determined by observation, setting up sticky traps and dissecting microscope analysis. The data was analyzed using Friedman's two-way nonparametric ANOVA.*

Results: *White flies (Uncle-334.3, Biashara-446.33, Karembo-352.8, Tosha- 420, Nylon- 515.7) and aphids (Uncle-323.9, Biashara-459.6, Karembo-394.5, Tosha- 413.6, Nylon- 468.8) were the major pests recorded on green gram crops with population mean value per variety indicated in brackets. Other insect pests noted during the study season included African pod borers and leaf weevils. Nylon (severity of leaves damage-1991.0, incidence of pods damage- 0.328, number of holes poked in leaves- 3.11) proved to be the most resistant to whiteflies and aphids while Tosha (severity of leaves damage-2564.76, incidence of pods damage-0.599, number of holes poked in leaves-4.45) the least resistant to whiteflies and aphids.*

Conclusion: *Whiteflies, aphids, African pod suck borers and leaf weevils were the insect pests infesting the growing green gram varieties during the planted season with whiteflies and aphids causing major damages. N26 variety was the most susceptible to attacks but also the most resistant to damage and loss.*

Key Words: *Green grams, Insect pests, Aphids, White flies, Resistance, Varieties*

Date of Submission: 09-10-2023 Date of Acceptance: 19-10-2023

I. INTRODUCTION

Green grams (*Vigna radiata*) are also known as mung beans [1]. The Swahili word for the green grams is ‘ndengu’ and is commonly referred to as ‘nkina’ in kitharaka, the native language in Tharaka Sub- County. In Kenya, they grow well in semi-arid areas like Tharaka, Mwingi just but to name a few*[2]*. Green grams farming is the main source of revenue collection in Tharaka Nithi county and plays a vital role in the country at large by ensuring food security, creating employment for rural households and greatly contributing to the national economy [3]. In fact, it is the second highest income generating agro-enterprise after indigenous chicken. Green grams are also of high nutritive value (proteins-14.2g, carbohydrates-38.8g, fats-0.8g, fibre-15.4g, sugar-4g, calories-212) and known to greatly contribute to healthful wellbeing of the consumers [4].

Cultivation of green grams encounters many challenges such as disease and insect pest infestation [5]. These challenges affect the general performance of the crops and consequently lead to low productivity. Insect pests known to affect this crop include; cutworms, aphids, root-knot nematode, pod-sucking bugs, pod-borers, red-spider mites and spiny pod borer [6]. These insects affect the crops at different developmental stages including vegetative, flowering and different other parts of the crop such as roots, leaves, flowers and pods [7]. The overall

outcome of these attacks is reduced productivity, which is measured in terms of overall yield's quantity and quality.

Field pest studies are vital in reducing the loss caused by pests which ultimately lead to decreased productivity and consequently affect all the other benefits associated with green grams like economic value and nutrition [8]. Insect pest infestation in the field has been reported to cause approximately 50 to 90% loss in productivity of green grams. The percentage loss is dependent on the type of insect pest attacking and the frequency of attacks [9]. Climate change effects leading to increased temperatures has been reported to favor surge in numbers of insect pests and may consequently cause increased infestation [10]. In the present study, the green gram varieties that are more resistant to insect pests were evaluated by comparing the levels of damage in vegetative and reproductive parts in respect to the population of insect pests recorded in each variety. Less damaged varieties were deemed to be more resistant and therefore less susceptible to attack by insect pests.

II. MATERIALS AND METHODS

Study Site

The study was done at two Tharaka Sub-County sites; Tharaka University farm (altitude of 621 meters above sea level) and at Irunduni farm in Mukothima ward (altitude of 780 meters above sea level). The map of the study areas is shown in figure 1. Tharaka region has two rainfall patterns, the long rains falling between March-May and the short rains between October- December. The sub-county's precipitation ranges between 500-800 mm yearly and temperatures range between 24-37^{o}C although at times it can rise to 40^{o}C. Mukothima and Tharaka University sites have different agroclimatic zones as elaborated by Kibetu [11]. Mukothima is classified under agroclimatic zones 1(ACZ1) and agroclimatic zones 2(ACZ2). The temperatures at Mukothima zones averages between 21.6^{0}C- 22^{0}C and aridity index of between 0.30 and 0.45. Tharaka University on the other hand has temperatures of between 22^{0}C -22.6^{0}C and an aridity index of 0.30- 0.55.

Identification of Field Insect Pests

The field insect pest determination method was adopted from Kinyanjui and coworkers, with some modification[12]. The type and population of insect pest was determined by means of observation and manual counting. Agronom-2005, PP yellow and blue coated fly insect sticky traps obtained from local agrovets were set up at each treatment to trap insects [12]. The traps were then divided into portions of 5 by 5 cm on both sides of the traps and the insects counted with the aid of a magnifying hand lens. For the aphids that could hardly be counted using naked eyes, they were scrapped off the pods and stems, preserved in 10% ethanol and counted using a dissecting microscope (NTX-3C plus DCE-2 model) [13]. The insects observed were compared with the data from EPPO Global Database (https://gd.eppo.int/photos/insecta) with the help of an entomologist.

Determination of Most Resistant Green Gram Variety

For each treatment, ten plants were sampled avoiding the border plants because of the field margin effects. In each plant, five leaves were selected randomly and the holes in the those leaves counted and recorded. The total number of leaves damaged in each plant was also recorded out of the total number of the leaves in that plant. The tota lnumber of damaged pods out of the total pods in each plant was also recorded. During harvesting, the total number of pods harvested per plant were recorded and then after threshing, each treatment's individual yield was recorded. Resistance was measured according to severity of leaf damage [14]. Insect resistance was evaluated in five leaves (or other plant parts) per plant and the following scale was adopted;

Table 1: Insect resistance evaluation scale

Criteria	Score
No damage and infestation	1
Light damage and infestation 5% plant parts damaged or infested by pest	2
Average damage and infestation 5 and 50% plant parts damaged	3
Considerable damage and infestation 50% plant parts damaged and severe stunting or wilting	4
Plants with very high infestation levels and severity of damage or wilted and dead plants	5

The field studies were done in four replicates and reported in mean values. The results were expressed as mean ± SE (standard error). The data on aphids, white flies, leaf weevil and African pod suck borer was analyzed using the Friedman's two-way nonparametric ANOVA procedure of SAS 9.2. The mean separation was done using Tukey's HSD (Tukey's Honestly Significant Difference Test) at 5% significance.

Statistical Mode:

$$Y_{ijk} = \mu + V_i + \beta_j + \varepsilon_{ijk}$$

Where;

$\mathbf{Y_{ijk}}$ = dependent variables,

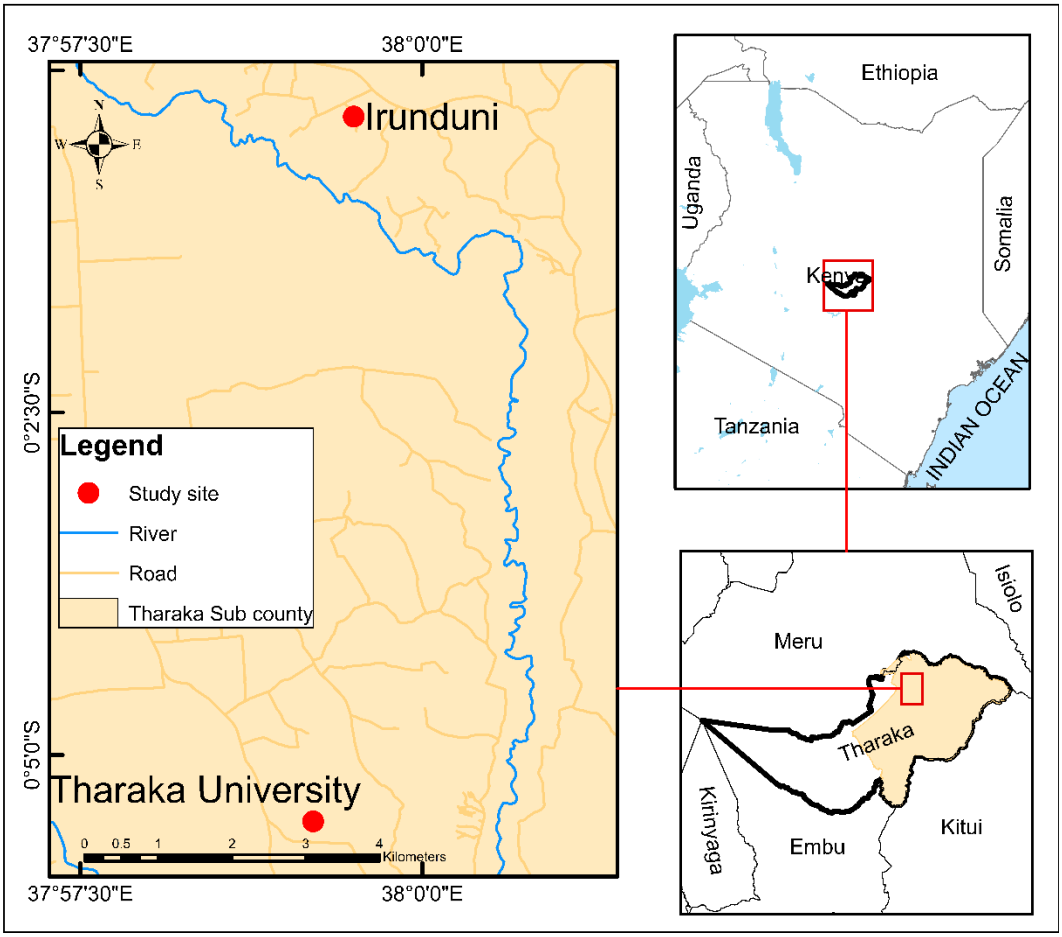
$\boldsymbol{\mu}$= overall mean,

$\mathbf{V_i}$ = Fixed effect due to i^{th} variety (i= N26, KS20, Ndengu Biashara, Ndengu Tosha, Ndengu Karembo)

$\boldsymbol{B_J}$=Fixed effect due to j^{th} block (j=Tharaka University site and Mukothima site)

$\boldsymbol{\varepsilon_{ijk}}$= Random error

Figure 1: Map representation of the study sites



III. RESULTS AND DISCUSSION

Insect Pest Determination

The variety of green grams with the highest mean number of white flies was Nylon (N26), followed by Biashara, Tosha, Karembo and Uncle (KS20) in that order. The mean number of white flies in N26, the highest (515.7), differed with the lowest recording variety KS20 (334.3) by an average value 181.4 (<0.05). The same pattern of infestation was observed for aphids with Nylon (N26) recording the highest (468.8) mean number and Uncle (KS20) recording the lowest (323.9) (table 2). In general, N26 variety was the most susceptible to insect pest attacks while the KS20 was the least susceptible. Previous studies have reported that susceptibility to attack could be attributed to high leaf moisture content and low trichome density on the leaf surface [9]. More studies should be done to determine whether these factors could have contributed to the susceptibility of the N26 variety. The infestations by African pod suck borers and leaf weevils were also noted, although their mean values were low and not significantly different in all the studied varieties (<0.05).

Table 2: Insect types and numbers in the planted green gram varieties

	Varieties						P value	
Parameters	**N26**	**KAREM**	**KS20**	**BIASH**	**TOSHA**	**SEM**	**Variety**	**Site**
White flies	514.7a	352.8b	334.3b	446.33c	420c	12.2	0.0001	0.0166
Aphids	468.8a	394.5b	323.9c	459.6ad	413.6db	12.08	<0.001	0.031

AFB	0.250	0.125	0.120	0.250	2.625	1.13	0.493	0.441
Leaf Weevil	1.00	0.875	2.50	2.50	1.750	0.71	0.327	0.0013

Means within a row with the different superscript letters are statistically different (p <0.05).
White flies- *Bemisia tabaci* Aphids- *Aphis craccivora* African pod suck borer- *Riptortus pedestris*
Leaf weevil- *Otiorhynchus sulcatus*
AFB-African Pod Suck Borers, KAREM- Karembo, BIASH- Biashara

Thus, the insect pests observed in the study sites were white flies (figure 2), aphids (figure 2), African pod borers (figure 3) and leaf weevils (figure 4). It was also noted that white flies and aphids caused most significant damage on the planted green gram varieties. These study findings are in agreement with those reported in previous studies on other gram varieties [9, 15]. Although some previous research studies reported more types of insect pests attacking green grams including many types of pod boring insects, the numbers and types of insects in this study were fewer (four species). This could have been attributed to changing ecological zones and seasons, the two main factors that determine the types of insect pests that attack crops according to Altieri and coworkers[16]. There were some insects like African pod borers and leaf weevils in Mukothima site that were not present in Tharaka University, a much drier site than the former.

Figure 2: A- Aphids and White flies on stem, B- Aphids and Whiteflies and pods, C- Aphids and White flies on Yellow trap, D- Aphids and White flies on Blue trap.

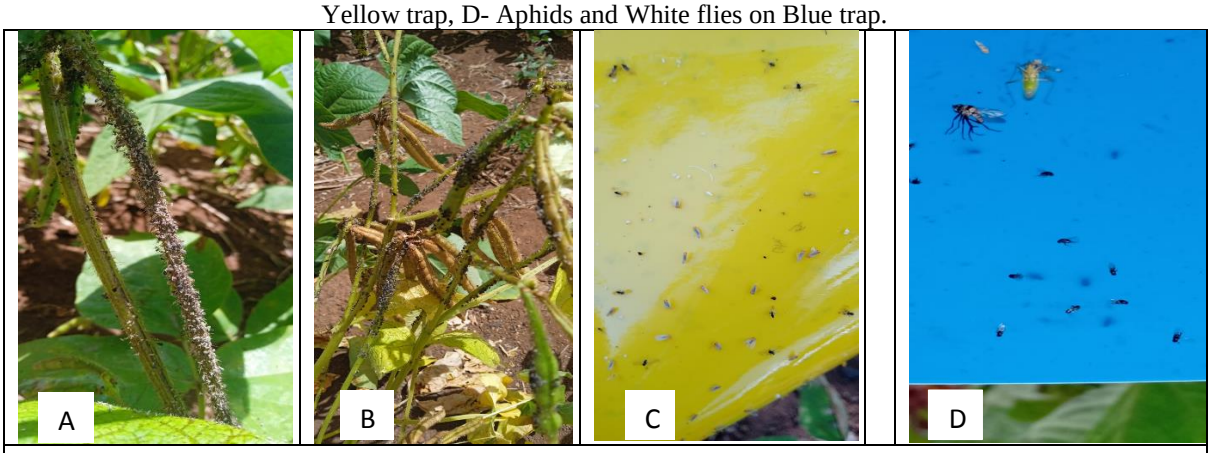


Figure 3: A- Pod borers on stem, B- Pod borers on leaf, C- Pods poked on pods by pod borers

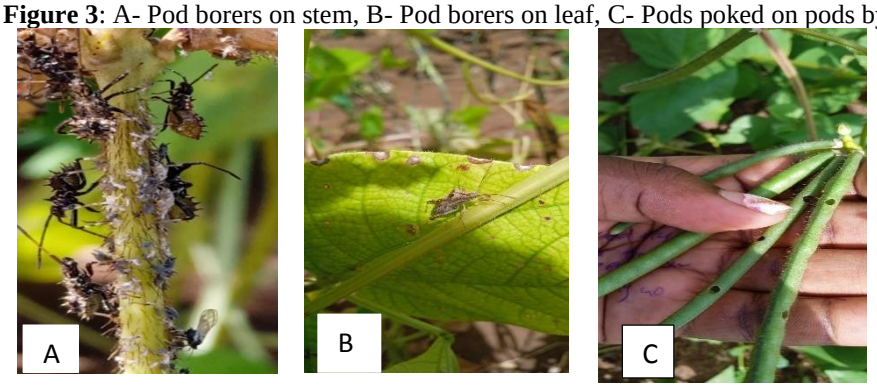


Figure 4: A- Leaf weevil, B- Leaf weevil poking holes on leaf, C- Leaf with poked holes

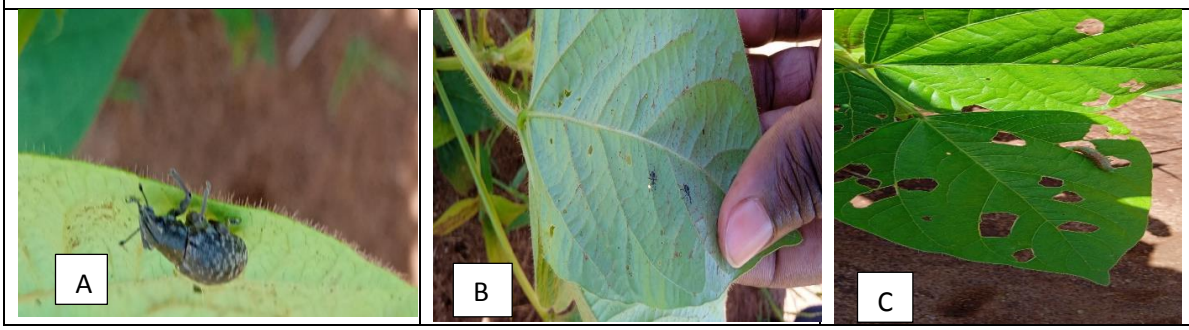


Figure 5: Malformed pods due to pest infestation

Determination of resistant green gram variety

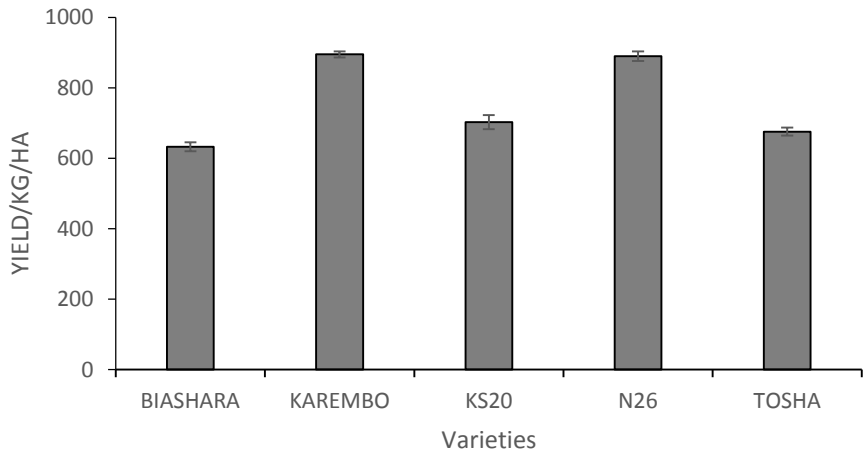
Resistance of the selected varieties was determined by observing severerity of pod and leaves damaged. Tosha variety had the highest damage index (2564.76), implying that it had the highest severity of leaves damaged, followed by Biashara (2275.6), Karembo (2245.17), Uncle (2029.8) and Nylon (1991.0) varieties in that order (table 3). In addition, Tosha variety had the highest number of holes with a mean value of 4.45 while N26 had the lowest with a mean value of 3.11. Another measure of pest resistance was evaluation of the incident rate for pod damage. Nylon (N26) had the lowest pod damage rates while Tosha recorded the highest. It is also worth noting that N26 had the highest number of pods harvested with a mean value of 22.9 while KS20 had the least value harvested of 18.8. These results indicate that N26 had the highest resistance against insect pests despite having the highest susceptibility. The highest resistant variety (N26) also recorded the highest yields (figure 6).

Table 3: Incidence of Pods Damage and Severity of Leaves Damage

	Varieties						P value	
Parameters	**BIASH**	**KAREM**	**KS20**	**N26**	**TOSHA**	**SEM**	**Variety**	**Site**
No. of pods	20.4ab	22.0b	18.8a	22.9b	22.3b	0.75	<0.001	<0.001
Incidence rate for pods	0.546a	0.590 b	0.380c	0.328cd	0.599ab	0.11	<0.001	<0.001
S.L damage	2275.6a	2245.17a	2029.8b	1991.0c	2564.76d	23.2	<0.001	<0.001
No of holes	3.33ad	4.08c	3.52d	3.11e	4.45b	10.8	<0.001	<0.001

Means within a row with the different superscript letters are statistically different (p <0.05).
AFB-African Pod Suck Borers, KAREM- Karembo BIASH- Biashara
S.L-Severity of leaf damage
SEM-Standard Error of Means

Figure 6: Yields of different green gram varieties



IV. CONCLUSIONS

In conclusion, whiteflies, aphids, african pod suck borers and leaf weevils were the insect pests infesting the grown green gram varieties during the planted season with whiteflies and aphids causing major damages. N26 green gram variety recorded the most infestation with whiteflies and aphids. Nevertheless, the variety (N26) was observerd to have the highest insect pest resistance with least pods and leaves damage and consequently recorded the highest yields.

ACKNOWLEDGEMENT

I would like to thank Tharaka University for funding the project and for availing their facilities and space to successfully carry out the project.

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