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Integrated management of pigeon pea pests improves yields in Kenya

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ABSTRACT

This study was conducted in lower eastern Kenya to compare the impact of various management practices on pigeon pea pests. Six and eight farms planted with pigeon pea crops were used in seasons one and two, respectively, based on Agro-Ecological Zones (UM & LM). In each farm, three plots were established where pests were managed using integrated pest management (IPM), farmer practice (FP), or control without pest management, as a check. Results showed a highly significant difference ($p<.001$) in the pigeon pea grain yields with 1.66±0.041; 0.91±0.042 tons per Ha for UM and LM Agro-ecological zones, respectively. An increase of 43.29% and 52.35% in the number of pods was recorded in IPM and FP-managed plots, respectively, compared with the control. Furthermore, pod weight (g) for the IPM plot increased by 39.24%, while in the FP-managed plots, it increased by 48.22%. Additionally, grain weight (g) increased by 34.77% in the IPM and by 51.60% in the FP-managed plots. A significant ($p=0.05$) increase in percent protein content was recorded, with 16.85%, 16.67%, and 14.64% from FP, IPM, and control-managed plots, respectively. Pest management is a key input in pigeon pea production, and farmers need to manage pests for improved yields.

Contribution/Originality: Integrated pest management methods applied were based on scouting decisions on the farm. The results provide farmers with clear evidence of the effectiveness of scouting and the benefits of IPM when applied across all crop pest challenges.

1. INTRODUCTION

Pigeon pea (*Cajanus cajan* L. Millsp.) is a protein-rich grain leguminous plant, serving as a source of fuel, fodder, fencing material, and contributing to soil fertility while helping to manage soil erosion [1]. High nutritive value has been attributed to the grains [2] as food, whereas the foliage is extensively used as fodder and feed for livestock [3].

Pigeon pea yields in African nations are very low, with Kenya producing an average of 0.40 tons per hectare [4] Uganda 0.45 tons per hectare [5] and Nigeria 0.7 tons per hectare [6] since 2004, this is in contrast to the

average yield potential of between 1.5 and 2.5 t ha^{-1}, observed in India, and up to 3 t ha^{-1} in Malawi [7]. The reduced grain yield may be attributed to biotic and abiotic pressures, which include drought, diseases, insect pests, lack of quality seeds, and poor production practices, among others [8].

Reductions in crop yields due to pests (insects, mites, pathogens, and weeds) have been a significant risk to the incomes of rural populations and global food security [9]. Insect pests have been described as causing 15-25% destruction in pigeon pea in India [10]. In Africa, a study conducted on pigeon pea in Nigeria documented a significant 78% yield loss caused by pod-sucking bugs [11].

Seed damage caused by pod-sucking bugs in Kenya, Malawi, Tanzania, and Uganda ranged from 3% to 32% and varied among locations, within and between countries [12]. Disease losses in pigeon pea have been projected at 5-10% in India. [10] with the recent work by Sharma et al. [13] specifying that Fusarium wilt, a severe disease in major pigeon pea production regions of the world, could cause yield reductions ranging from 18.86% to 54.24%. Previous studies have reported that the yield loss in a pigeon pea monocrop due to weeds was between 32% and 90% [14].

2. METHODOLOGY

This study was conducted in Machakos County, Lower Eastern Kenya (Figure 1). The county is situated within latitudes 0° 45' south and 1° 31' south, and longitudes 36° 45' east and 37° 45' east, in a region characterized by semi-arid to arid climates [15]. Temperatures vary between 9.1 and 26.7°C, and rainfall ranges from 500 mm to 900 mm annually. The county is situated at an altitude of 1,000 to 1,600 meters above sea level [16].

Pigeon pea, variety Mbaazi II, seeds treated with Thiram to protect against soil-borne pathogens, were sourced from KALRO - Katumani for planting in farmers' fields. Sowing of pigeon pea seeds was undertaken at the onset of the October-December rains, with row-to-row spacing of 100 cm and plant-to-plant spacing of 50 cm [1].

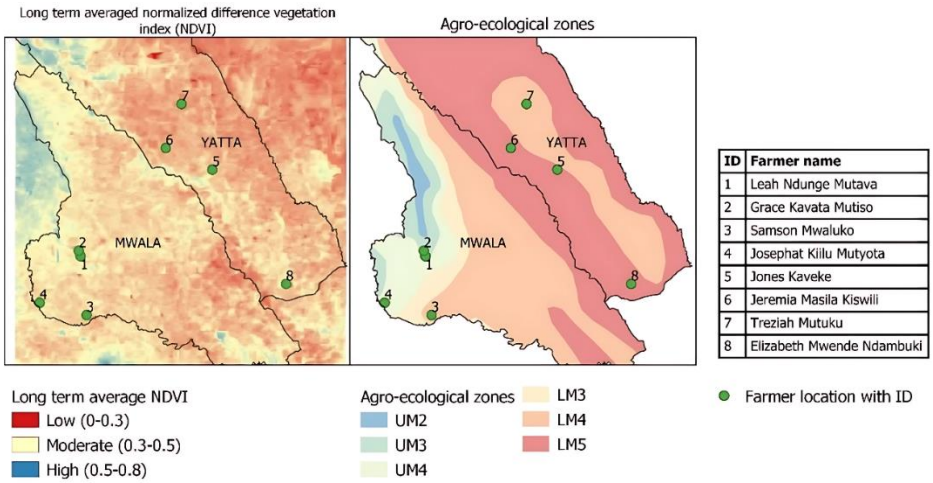

Figure 1. Study site map (Matolo Nyamai, 2023).

2.1. Experimental Design

The trial was conducted in a farmland. Each farm served as a block. The experiment was replicated across eight farms in season one (October 2020 – September 2021), with four farms in each Agro-Ecological Zone (AEZ), UM and LM. In season two (November 2021 – September 2022), it was replicated in six farms, with three farms in each AEZ (UM and LM). Each farm, planted with pigeon pea, was divided into three plots separated by five-meter buffer strips with pigeon pea crops. Treatments in each farm included pigeon pea with

integrated pest management (IPM), a crop where pest management was performed according to farmers' practices (use of synthetic insecticides, non-IPM), and a control without pest management.

Total grain yields were determined for each treatment at harvest, where forty plants were randomly selected, and dry pods were harvested. Yield parameters included pods per plant, weight (g) of pods per plant, number and weight (g) of seeds per plant. Yield data from different pest management practices were subjected to analysis of variance (ANOVA) to determine whether significant differences existed among the means [17].

3. RESULTS

Highly significant differences (p<.001) in number and weight (g) of pigeon pea pods and grains were recorded in different agroecological zones (UM and LM). Upper midland zone had increased percentage of pods (35.71%), weight (g) of pods (43.71%), number of grains (69.61%) and weight (g) of grains (45.39%) per pigeon pea plant. Grain yields of 0.91 tons and 1.66 tons per hectare in LM AEZ and UM AEZ, respectively, were recorded. This translates to an 82.42% increase in pigeon pea yields under UM AEZ compared to LM AEZ (Table 1).

Table 1. Mean number and weight (g) of pigeon pea pods and grains for different Agro ecological zones (AEZ), combined for seasons one & two in Machakos County, Kenya.

AEZ	No of pods per plant	Weight (g) of pods per plant	No of grains per plant	Weight (g) of grains per plant	Weight (Tons) of grains per Ha
LM	72.28±3.16	75.20±3.45	278.4±12.61	45.44±2.12	0.91±0.042
UM	112.42±2.73	133.60±3.16	472.2±12.05	83.21±2.10	1.66±0.041
t- value	-9.61	-12.48	-11.11	-12.66	-12.66
df	1343	1384	1361	1361	1361
p- value	<0.001	<0.001	<0.001	<0.001	<0.001

Combined pigeon pea yields for both cropping seasons showed highly significant differences (p<0.001) in the number and weight (g) of pigeon pea pods and grains. The mean number of pods in the control, IPM, and FP managed plots were 70.28, 100.71, and 107.07, respectively. This represented a 43.30% and 52.35% increase in the number of pigeon pea pods per plant in the IPM and FP managed plots, respectively. Pod weight (g) per pigeon pea plant from the control, IPM, and FP managed plots were 81.3, 113.2, and 120.5, respectively. There was a highly significant difference (p<0.001) in pod weight between the treatments, translating to a 39.24% and 48.22% increase in pod weight (g) per plant in the IPM and FP managed plots, respectively (Table 2).

There were highly significant differences (p<0.001) in the number and weight (g) of grains per pigeon pea plant. Additionally, 285.2, 401.6, and 443.1 grains per plant were harvested from the control, IPM, and FP managed plots, respectively. This indicates that IPM resulted in a 40.81% increase, while the FP managed plot showed a 55.37% increase in the number of grains per pigeon pea plant. The weight (g) of grains per pigeon pea plant from the control, IPM, and FP managed plots were 50.19, 67.64, and 76.09, respectively. This represents a 34.77% increase from the IPM and a 51.60% increase from the FP managed plot per pigeon pea plant (Table 2).

Table 2. Mean number and weight (g) of pigeon pea pods and grains for different treatments, for seasons one & two in Machakos County, Kenya.

Treatment	No. of pods per plant	Weight (g) of pods per plant	No. of grains per plant	Weight (g) of grains per plant
Control	70.28±3.69^{b}	81.30±4.25^{b}	285.20±15.68^{b}	50.19±2.72^{b}
IPM	100.71±3.61^{a}	113.20±4.15^{a}	401.60±15.14^{a}	67.64±2.63^{a}
Farmer practice	107.07±3.64^{a}	120.50±4.19^{a}	443.10±15.59^{a}	76.09±2.71^{a}
p value (5%)	< 0.001	< 0.001	< 0.001	< 0.001
LSD (5%)	10.12	11.64	42.91	7.46
CV (%)	84.36	85.69	87.3	88.42

Note: The letters a and b denote groups of means that are statistically significant at the 5% level (P<0.05).

During this study, pest management impacted the protein (%) content in pigeon pea grains harvested from different plots. Protein contents of 14.64%, 16.67%, and 16.85% were recorded in pigeon pea grains from the control, IPM, and FP managed plots, respectively. This indicated that pest management increased the protein content of pigeon pea by 13.8% (IPM) and 15.1% (FP) managed crops (Figure 2).

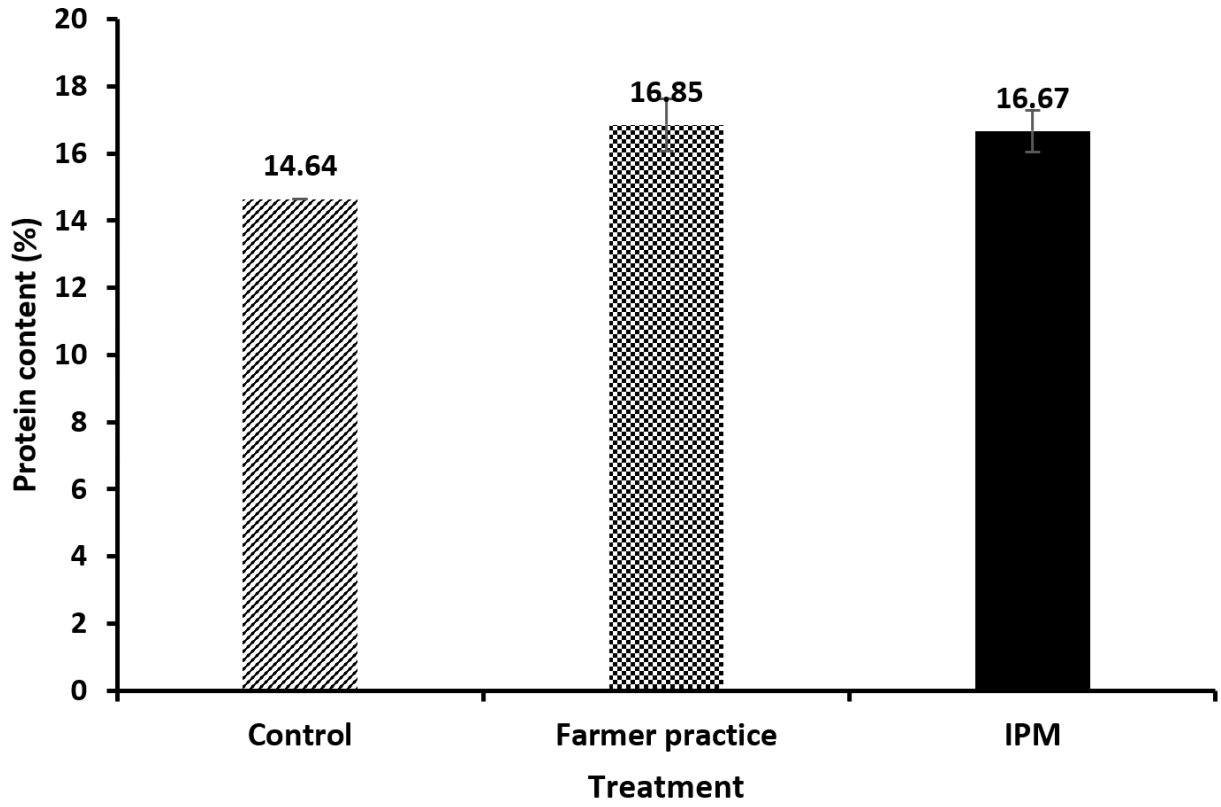

Figure 2. Protein (%) in pigeon pea grains from different plots in Machakos County, Kenya.

4. DISCUSSIONS

This study noted that the Upper Midland Agroecological Zone (UM AEZ) had the highest pigeon pea yield in terms of the number and weight of pods and grains. Similar results have been reported for pigeon peas [18], although working on different AEZs (LM4 and LM5) through a survey conducted in Machakos County, Kenya, where LM4 had higher yields. Similar reports have been documented, indicating that agro-ecological zones determine crop suitability [19, 20].

During this study, crop losses of up to 34.04% when insect pests were not managed were recorded. Although at a lower percentage, Sharma et al. [21] reported yield losses of 15–25% caused by pests in both pigeon pea and chickpea in India. However, in Kenya, most yield loss studies have been undertaken on stored grains, where losses as high as 50% have often been encountered in some of the important legumes such as faba bean, field pea, chickpea, and lentil from some aggressive storage insect pests like *C. chinensis* [22].

Results from this study indicate that pest management on pigeon pea increased protein (%) content by up to 15.1%. This implies that pigeon pea produced under pest pressure will have low protein content, thus resulting in low-quality food/feed. Similarly, a protein content of 22.3% has been reported in other studies [23]. However, although not related to nutritional composition, pests are known to reduce the quality of farm produce, such as appearance, shape, size, and color [24]. Additionally, a significant amount of loss evaluation due to pests has been conducted on stored grains, where seeds of legumes, once damaged by storage insects, are no longer suitable for planting (due to poor germination) or for food and feed, owing to spoilage and bad odor [25].

Pest management is an essential input in pigeon pea production to enhance both quantity and quality. It is recommended that pest management be implemented during the cultivation of pigeon peas. Additionally, the upper midland (UM) AEZ is preferable to the lower midland (LM) for pigeon pea production in Machakos County, Kenya.

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