Assessment of the resistance and performance of pigeon pea (Cajanus cajan [L.] Huth) cultivars to selected major insect pests of at Bunda, Malawi

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Abstract. A study to evaluate the resistance and performance of six varieties of pigeon pea (Cajanus cajan [L.] Huth) against major insect pests was conducted at Bunda College of Agriculture, Malawi during the 2017/2018 cropping season. The experiment was arranged in a Randomized Complete Block Design (RCBD) with three replicates. Results indicated that cultivars varied in number of days to flowering with ICPL 87105 (82 days) and ICPL 93026 (97 days) flowering earlier than the rest of the treatments. In addition, significant differences (p<0.001) were observed in yield with ICEAP00040 (925.2 kg ha⁻¹) and ICPL 9145 (1009.6 kg ha⁻¹) having higher grain yield (kg ha⁻¹) and less damaged pods than the rest of the cultivars. Cultivars ICEAP 00040 and ICEAP 01514/15 had significantly lower damaged pods 23.08% and 26.55% respectively as compared to other cultivars followed by ICPL 87105, ICPL 9145 and ICEAP 00557 respectively. There is potential of realizing high yields in late maturing varieties such as ICPL 00040 and ICEAP 9145 grown without the application of any pesticide.

1. Introduction

Pigeon pea (Cajanus cajan [L.] Huth) is one of the major grain legume (pulse) crops of the tropics and subtropics. It is believed to have originated from India which is still its main area of cultivation [1]. Pigeon pea is widely grown by small holder farmers in the semi-arid tropics as a backyard subsistence crop. It is produced in large quantities in India and commercially produced in countries like Kenya, Malawi, Mozambique and Uganda [2].

In Malawi the present average yield ranges from 400 to 800 kg ha⁻¹, but its potential yield of up to 2500 kg ha⁻¹ can be obtained in a pure stand [3]. Growing pigeon peas in Malawi as in other countries is limited by the incidence of diseases and insect pests which attack the crop from seedling to maturity. About 80 - 90% of farmers across the country grow pigeon pea without spraying any pesticide [4] which...
led to crop loss of up to 70% [3]. This is attributed by high cost of chemicals, limited funds to buy pesticides and lack of technical know-how, on how to properly use the pesticides. Due to inadequate information as to how much a farmer would harvest after the attack and which variety is more resistant/tolerance to insect pest attack, there was a need to assess the resistance and performance of different pigeon pea varieties to major selected insect pests.

2. Materials and Methods

2.1 Place, materials and tools

The study was conducted at research and teaching farm of Bunda College, Department of Crop and Soil Sciences, Lilongwe University of Agriculture and Natural Resources (LUANAR), Central region, Malawi in 2017/2018 growing season. The site is located at a latitude of 14º35´S, longitude of 33º50´, and at an altitude of 1159 m above sea level. Materials used were seeds composed of 6 varieties which were collected from ICRISAT Centre located at Chitedze Research Station in Lilongwe, and tools like hoes, panga knife and ropes were used.

2.2. Methods

The treatments were arranged in a Randomized Complete Block Design (RCBD) to control environmental variation, with three replicates. The total experimental area was 49m by 49m (2401m²) with each plot having 15m by 7m (105m²). There was a buffer zone of 1m between blocks (B1, B2, and B3) and within plot (V1, V2, V3, V4, V5, and V6) (figure 1). The plot consisted of 10 ridges which were 15m long and spaced at 0.75m apart. Seeds were sown at the rate of three seeds per planting station spaced at 1m in each ridge. A net plot area of 8.25m by 8m (66m²) was located at the centre of each plot on which data was collected.

![Figure 1. Field layout of RCBD with different varieties; V1, V2, V3, V4, V5 and V6.](image)

All cultural practices in the cultivation of pigeon pea were followed as recommended by the Ministry of Agriculture and Food Security [3], apart from the application of pesticides and fertilizer. The growing season during which the crop was grown, was characterized by medium unimodal rainfall of about 1031mm falling between October/November up to April.

2.3. Data collection and analysis
Data was collected from each net plot on the following parameters; days to flowering, total number of harvested pods, number of damaged pods (%), yield (kg ha\(^{-1}\)) and major insect pests counted and scored. Basically 12 plants were randomly sampled from two diagonals on each net plot, 6 plants were scouted per each diagonal. Yields from each net plot were weighed using a top scaled balance and averages were calculated to get the mean yield per hectare for each variety.

Major insect pests of economic importance were handpicked and immediately taken to entomology laboratory for identification, these included; African bollworm (*Helicoverpa armigera*), *Clavigralla gibbosa* and *tomentosicollis*, *Mylabris* spp, pod fly (*Melanogromyza obtuse*), elegant grasshopper (*Zonocerus elegans*) and Aphids (*Aphis craccivora*). All these were collected by hand picking and sweeping technique methods.

Aphids (*Aphis craccivora*) were determined by counting the number of infested leaves and pods on the net plot. Generally, visual count and the assessment of infestation by insect pests on pigeon pea was done as per scale given by [5] with infestation scale of 1-4 being used.

The technique usually involves finding the total population of plants on the net plot and grade infested plants as illustrated below:

- **Grade-1**: Scattered appearance of few aphids on the plant.
- **Grade-2**: Severe infestation of aphids on any one branch of the plant.
- **Grade-3**: Severe infestation on more than one branch or half portion of the plant.
- **Grade-4**: Severe infestation of aphids on the whole plant.

Percentage incidence (PI) = Number of infested plants / Total plant observed × 100.

Severity index (SI) = Sum of total grade points (1-4 infestation grade G-1 to G-4, respectively) of the infested plants / Total number of infested plants observed. The analysis of variance (ANOVA) one way was used to compare treatment means using R STATISTICAL, [6] computer package and means were separated using Tukey test at 5% level of significance.

3. Results and discussion

3.1. **Mean days to flowering, yield, number of pods and percentage of damaged pods.**

There were no significant differences on germination (%) in all the varieties i.e. germination ranged from 85% to 95.5% as shown in table 1 which was an indication of high-quality seed. In addition, it is believed that the conditions necessary for germination such as soil moisture, aeration and others were optimum. However, significant differences were observed on number of days to flowering with ICEAP 00040 and ICPL 9145 having significantly a greater number of days to flowering i.e. 172 (days) and 167 (days) respectively, followed by ICEAP 01514/15 (129days) and ICPL 00557 (119 days after planting). Only ICPL 87105 significantly flowered earlier than the rest of the cultivars (82 days) this was attributed to genetic makeup of the variety since it was bred to be an early maturing variety. Generally, early maturing varieties started to flower 73 days after planting with an average of 82 and 97 days for ICPL 87105 and ICPL 93026 respectively.

Yields were significant among varieties (P< 0.001) with ICPL 00040 (925.2 kg ha\(^{-1}\)) and ICPL 9145 (1009 kg ha\(^{-1}\)) having higher yields than the rest of the varieties. Furthermore, ICPL 93026 and ICPL 87105 had significantly lower yield as compared to other varieties i.e. 511.3 and 581.0 kg ha\(^{-1}\) respectively. Both ICEAP 00040 and ICPL 9145 had significantly a greater number of pods harvested followed by ICEAP 01514/15 (193, 192 and 169 respectively), the rest had statistically similar number of pods harvested (table 1). ICPL 93026 had significantly higher percentage of damaged pods (50.1%) as the cultivar was associated with high presence of insect pests; however the rest had statistically similar number of damage pods which contrasted with Dasbak et al. [12] who reported a significant difference.
However, this disparity might be due to difference in geographical locations, weather conditions and cropping system. Dasbak et al. [12] result was obtained in an intercropping system while this study was conducted on a pure/mono-cropping system. ICPL 00040 and ICPL 9145 were the promising varieties revealed by yield levels which were higher than the rest of the varieties.

Table 1. Mean days to flowering, yield, number of pods and percentage of damaged pods.

| Variety     | Germination % | Days to Flowering | Yield (kg ha⁻¹) | Number of harvested pods | Damaged pods (%) |
|-------------|---------------|-------------------|-----------------|--------------------------|------------------|
| ICEAP 00040 | 85            | 172.3c            | 925.2ab         | 193.4a                   | 23.08a           |
| ICEAP 01514/15 | 88        | 129.4b            | 783.4c          | 169.3b                   | 26.55ab          |
| ICPL 87105  | 90            | 82.3a             | 581.0d          | 119.0d                   | 29.07b           |
| ICEAP 00557 | 91.9          | 119.3b            | 812.0bc         | 122.0a                   | 29.88b           |
| ICPL 93026  | 94.4          | 97.4a             | 511.3d          | 135.3a                   | 50.10c           |
| ICPL 9145   | 95.5          | 167.6c            | 1009.6a         | 192.6c                   | 29.82b           |
| Fpr         | NS            | < .001            | < .001          | <0.001                   | <0.001           |

Means with preceding same superscript letters are not different at 5% level of significance.

3.2. The presence of major insect pests of pigeon pea observed at Bunda college farm

Results on major insect pest observed in all the varieties indicated that there were no significant differences among the varieties for *Clavigralla spp*. However, the larva of African bollworm (*Helicoverpa armigera*) were significantly lower on ICEAP 00040 as compared to ICPL 93026 and ICPL 87105 (Fpr<0.05).

The presence of *Zonocerus elegans* and *Mylabris spp* were higher in ICPL 93026 and ICPL 87105 than ICEAP 00040 and ICPL 9145 (Fpr < 0.05), the number of the rest of insects’ pests observed were statistically similar (Figure 2), as such ICPL 93026 was prone to insect pests attack more especially to *H. armigera* (10.45) as compared to ICEAP 00040 which was significantly lower i.e. (5.67), this was an indication that ICEAP 00040 is more resistance than the rest of the cultivars. *Clavigralla spp* which composed of sucking insect pests were common and statistically similar in all the varieties. Dasbak et al. [12] reported similar results on *Clavigralla spp*, but this did not affect the yield of ICEAP 00040 and ICPL9145 which were significantly higher.

Note: Means with same letters are insignificant at α = 0.01 level of significance
Figure 2. The presence of major insect pests of pigeon pea observed at Bunda college research farm

3.3. Percentage of incidence and severity index of aphids’ infestation on pigeon pea varieties

Aphids’ infestation was not as high as expected in many pigeon pea fields during the growing season. Only ICEAP 00557 had the highest score of 3 but with relatively a lower incidence of 11.23% and 3.097 severity index. ICEAP 01514/15 had the grade score of 2 with the highest percentage of incidence of 20.13 and a low severity index of 2.007. The rest had the grade score between 1 and 2 with percentage of incidence ranging from 7.5 to 17.1 and severity index ranging from 0.912 to 2.007 (Table 2). The level of low aphids’ infestation was assumed to have been attributed by weather conditions i.e. medium temperature (18-32°C), low relative humidity and medium rainfall.

Table 2. Results on aphids’ infestation on pigeon pea varieties on a grade score of 1-4.

| Variety     | Grade | Percentage of Incidence (%) | Severity Index |
|-------------|-------|-----------------------------|----------------|
| ICEAP 00040 | 2     | 8.86                        | 2.057          |
| ICPL 9145   | 2     | 17.10                       | 1.978          |
| ICEAP 01514/15 | 2   | 20.31                       | 2.007          |
| ICEAP 00557 | 3     | 11.23                       | 3.097          |
| ICPL 87105  | 1     | 5.34                        | 0.912          |
| ICPL 93026  | 1     | 7.50                        | 1.533          |

The peak populations of the insect pests occurred when the ICEAP 00040, ICPL 9145, ICEAP 01514/15 and ICEAP 00557 varieties were at their vegetative growth. Dasbak et al. [12] reported high insect pests infestation during vegetative and flowering stage which was caused by environmental conditions i.e. high temperature and relative humidity with high incidences of *H. armigera*. ICPL 87105 and ICPL 93026 flowered earlier therefore were prone to insect pest attack because more insect pests were recorded when ICEAP 00040 and ICPL 9145 were at its vegetative stage. The results however conquered with Kumar and Nath [7], that varieties which flower and mature late can escape insect attack. In this regard the most promising varieties were ICEAP 00040 and ICPL 9145 which had relatively higher yields compared to other varieties (Table 1). According to the results on yield component, ICEAP 00040 and ICPL 9145 were regarded as varieties with good resistance characteristic because of high yields even though similar number of *Clavigralla spp* insect pests attack were observed in all the treatments.

The selection of seeds for improved production will depends on insect pest’s resistance, seed quality characteristics and grain yield which were successful in this research based on yield and presence of insect pests. This is very important since insect pests are a major limiting factor to pigeon production among smallholder farmers’ fields [8]. However, resistance without considering consumer preferences for seed characteristics would lead to low adoption of these varieties. High incidences of *Clavigralla spp* were recorded in all the treatments (Table 2) however, pest damage levels are influenced by growth habit and duration of pigeon pea cultivars because late maturing varieties can escape the damage by insects which attack the crop when rains are at peak i.e. in months of January and February. Pigeon pea can compensate for the loss of its early crop to insect pest. If all or most of the first flush of flowers and pods are lost, then the plant will produce more flushes making its yield as good as that of the first flush if climate and insect pests allow it [1]. Results conquered with Ramar et al. [9] and Reed et al. [10] that genotypic differences, growth habits, and maturity durations of pigeon pea varieties differs, as a result pest damage may also differ especially under unprotected conditions. Yields of pigeon pea vary considerably among locations, cultivars, seasons, and cropping systems [9] but in this study insect pests were the most important yield constraint and the greatest cause of yield variation among varieties.
All the treatments were affected by aphid infestation and severity index was low in all the treatments (Table 2). High percentages of incidence were recorded in ICEAP 01514/15, ICPL 9145 and ICEAP 00557 with 20.31%, 17.10% and 11.23% respectively. Furthermore, the severity index which measures damage levels in pigeon pea by aphids were relatively lower with ICEAP 00040, ICEAP 01514 and ICEAP 00557 having the severity index of 3.097, 2.007 and 2.057 which had no effect according to [5]. Incidences of aphids have been evaluated on different pigeon pea varieties, aphids’ attack on pigeon pea crop at any stage of growth can cause serious damage if heavily infested. Infestation of up to 85% or more can occur depending on environmental factors [11]. However, the results obtained in this research on aphid infestation were lower than 85% which might be attributed to the climatic condition during the study period. In addition, resistance to infestation sometimes differs as a result of genetic make-up of the variety. Meanwhile, Kataria and Kumar [11] reported high infestation by aphids during the months of December-February at which early maturing varieties starts to flower while the medium and late maturing varieties are still at vegetative stage hence able to escape the attack more especially on floral attack.

4. Conclusion

The results indicated that more damage was observed in ICPL 87105, ICPL 93026, ICEAP 01514/15 and ICEAP 00557 varieties as compared to late maturity variety such as ICPL 00040 and ICPL 9145. High yields were realised in varieties ICPL 00040 and ICPL 9145 as such these would be recommended as they showed some resistant characteristic to some insect pest as revealed by yield quantity and number of damaged pods. Considerable potential exists for improving pigeon pea production among smallholder farmers by promoting the use of late maturing verities as these has shown some characters of resistance to some major insect pests of economic importance. However, this type of research needs to be repeated several times in different locations and/or agro-ecological zones in Malawi to establish an average yield that a smallholder farmer can obtain if pigeon pea is to be grown without the use of pesticides.

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