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Resistance Level of Mung Bean Genotypes to Pod Borer *Maruca testulalis* Geyer

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ABSTRACT

Background: Pod borer, *Maruca testulalis* is one of the harmful mung bean pests and cause substantial damage to the crop or failure to harvest. This study was carried out to identify the level of resistance to pod borer of mungbean accessions.

Methods: Field research was conducted at Muneng Experimental Farm, Probolinggo, East Java, Indonesia in the 2018 dry season using the randomized block design and repeated two times. A total of 50 accessions of mungbeans were planted in two growing environments, namely: L1 = controlled environment (*Maruca* pest was controlled with NPV biopesticide 2 g/liter of water) and L2 = uncontrolled environment (*Maruca* pest was not controlled with any kind of pesticide). Observations were made on the intensity of borer attack and dry seed weight.

Result: Eleven accessions gave a low resistant (LR) to moderately resistant (MR) categories responses against *M. testulalis* attacks. The pod damage from the eleven selected accessions was less than 15% under environmental conditions without control (L2). Control application (L1) reduced pod damage by 48.5% and increased mung bean seed yield by 25%, compared to without control (L2). The eleven accessions that were consistent or stable with low attack intensity under conditions with and without control gave dry seed weights above average, except for accessions (MLGV 0054, MLGV 0115 and MLGV 0320) which had dry seed weights lower than the average both in the growing environment with control (L1) or without control (L2).

Key words: Accession, Intensity, Mungbean, Pest, Pod borer.

INTRODUCTION

Mung bean (*Vigna radiata*) in Indonesia is the third important upland food crops after maize and soybean. Mung bean can be planted on lowland of paddy fields in the dry season and on upland in the rainy season. Pests and diseases are one of the obstacles in the cultivation of mung bean crop. The main pests that are considered harmful to mung bean plants are thrips, armyworms (*Spodoptera litura*), pod borer (*Maruca testulalis* Geyer), pod-sucking bug (*Riptortus linearis* and *Nezara viridula*) and *Piezodorus hybneri* (Indiati and Ermawan, 2015).

Pod borer, *Maruca testulalis* is one of the harmful mung bean pests causing substantial damage to the crop or failure to harvest. Farmers generally spray with recommended concentrations (1-2 ml / l), with a frequency of spraying every two or three days. The insecticide active ingredient used is one type or mixture of two or more active ingredients, but the spray volume used is very low at only 100 l / ha, so the results are less than optimal. Besides the spray volume, the time and target of insecticide application are also less precise, as a result the target pest does not die, but instead the pest can become resistant (resistant) (Indiati, 2010). Aside from Central Java, pod borer is also an important pest in Experimental Stations in Muneng (Probolinggo), Jambegede, Kendalpayak (Malang), East Java (Indiati *et al.* 2017).

Pod borer larvae commonly attack flower buds, flowers and pods. Severe attack can cause all the first flowers to fail to become normalpods. Atachi *et al*. (2007) reported that the yield loss of cowpea seeds due to *M. virata* attacks ranged from 20-80%. In the Philippines and Indonesia, pod damage in yardlong beans is estimated to be around 80% and 25% (Ulrichs and Mewis, 2004; Hammig *et al*. 2008). Loss of seed yield about 40% due to *M. vitrata* damage has been reported occured in long beans and cowpea in Thailand (Phompanjai and Jamjanya, 2000; Yule and Srinivasan, 2013).

The use of commercial *Bacillus thuringiensis* (Turicide HP) and Azadiractin (neem seed extract solution) could be recomended for environmental safety though their effectiveness was lower than synthetic insecticide (Indiati, 2007). Neem seed kernel extract (NSKE) or neem oil and bioinsecticides like *Bacillus thuringiensis* (Bt) showed different levels of efficacy on pod borer in different crops (Mahalakshmi *et al.* 2016). The popular biopesticide NPV is known for high epizootic levels, is naturally occurring, self-

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perpetuating, safe to natural enemies and environmental friendly, because of its obligate nature and host specificity (Erayya *et al*. 2013).

The efficacy of different insecticides againts pod borer on chickpea has been reported by Lekha *et al.* (2017). Although insecticides are effective against sucking pests and pod borer complex, development of resistance, residues in short duration crop and environmental hazards demand alternative ecofriendly methods of management (Soundararajan *et al*. 2013).

Resistance evaluation of mung bean accession to pod borer pest needs to be done to obtain source of resistant genes against pod borer, which can then be used as resistant parents in the process of breeding resistant mung bean varieties The purpose of this study was to obtain information on the level of resistance of mung bean accession and to estimate the yield loss due to pod borer.

MATERIALS AND METHODS

Study area

Field research was conducted at Muneng Experimental Farm, Probolinggo, East Java Province, Indonesia with an altitude of 10 meters above sea level at the coordinates of 7°48′7.2″ South Latitude and 113°9′32.4″ East Longitude. The experiment was conducted during Dry Season (March-June 2018).

Material

A number of 50 mungbean accessions were used in this experiment. These mungbean accessions are part of more than 300 accessions collected by the Indonesian Legumes and Tuber Crops Research Institute (ILETRI), Malang, East Java, Indonesia.

Method

The field study was conducted using a Randomized Block design and repeated two times. The experiment consisted of two growing environments (L1 = controlled environment, *Maruca* was controlled with biopesticide NPV 2g/liter of water; and L2 = uncontrolled environment, *Maruca* was not controlled with any kind of pesticide).

Each mungbean accession was planted in a plot of 4 m in length and 2 rows per treatment with a plant spacing of 40 cm × 15 cm, 2 plants per hole. Fertilizer application was 45 kg Urea + 45-90 kg SP36 + 50 kg KCl/ha given during planting. In order to avoid thrips infestation, all treatments at 7 to 28 days and 1 week interval were treated with fipronil 2 ml/liter. If during pod monitoring, infested pods were found, the pods were sprayed with 2 ml/liter of deltamethrin or tiametoksam (0.1g/liter).

Pest control for non-target pests were carried out both in L1 (*Maruca* was controlled) and L2 (*Maruca* was not controlled) environments. For L2 control was not applied again after the plants of 14 days after planting (DAP). Whereas for L1, the next control used was NPV until the plants were spotted at intervals of 3 or 5 days.

Data analysis

Observations were made at 45, 48 and 51 days after planting (HST) by counting the number of symptomatic flowers / pods in each accession. The intensity of the pods attacked in 5 sample plants at harvest, dry seed yields from 5 sample plants and the entire plot at harvest. The intensity of pod borer attacks was calculated according to the formula:

$$I = a / (a + b) \times 100\%$$

I = intensity of plants or pods attacked.
a = Number of plants or pods attacked by borers.
b = Number of healthy plants or pods.

Loss of mung bean yields due to pod borer attacks can be calculated according to the formula:

$$YL = (YL1-YL2) / YL1 \times 100\%$$

YL = yield loss.
YL1 = yield of controlled plants.
YL2 = yield of uncontrolled plants.

The level of resistance of mung bean of each accession to pod borer pest was categorized based on the mean of pod or seed damage (X) and the Standard Deviation (SD) method developed by Chiang and Talekar (1980) as follows:

- HR (highly resistant): < X - 2 SD
- MR (moderately resistant): between X - 1 SD to X - 2 SD;
- LR (low resistant): between X and X - 1 SD
- S (susceptible): between X and X + 2SD
- HS (highly susceptible): >X + 2 SD.

Where
X = Mean of pod damage or seed damage.
SD = standard deviation.

Base on that formula, the accession that had insect numbers less than X - 2 SD was considered highly resistant (HR) and the accession that had insect numbers more than X + 2 SD was considered highly susceptible (HS).

RESULTS AND DISCUSSION

Resistance category to pod borer

Summary of 50 mungbean accessions of seven characters observed related to pod borer evaluated in two environments is shown in Table 1. As the plant age increased from 45 to 53 days after planting (DAP), there were increase in pod borer attack, both in the controlled (L1) and uncontrolled (L2) growing environments. At 51 DAP the number of plants infested in L2 ranged between 5.8% and 28.8% with an average of 14.5%, while in the L1 the number of plants infestation ranged between 0.5% and 11.1% with an average of 4.3% which was significantly different from L2 (Table 1).

Number of plants attacked by pod borer at 45, 48 and 51 DAP average of 50 mung bean accessions is shown in Fig 1. The percentage number of plant infested by pod borer in uncontrolled environment at 45, 48 and 51 DAP were 3.6%, 8.9% and 14.5%, respectively, which were two - three times higher than those infested in controlled environment (0.9%, 2.7% and 4.3%, respectively).

Table 1: Summary of 50 mungbean accessions on five characters observed related to pod borer evaluated in two environments. Muneng experimental station 2018.

No.	Characters observed	L1 Controlled Environment[a]			L2 Uncontrolled Environment[a]		
		Range of 50 accessions	Mean	SD[c]	Range of 50 accessions	Mean	SD[c]
1	Number of plants infested by pod borer in 45 DAP (%)[b]	0.0 – 2.4	0.9	0.7	0.5-9.6	3.6	2.4
2	Number of plants infested by pod borer in 48 DAP (%)[b]	0.5 – 7.2	2.7	1.6	3.4-22.1	8.9	4.3
3	Number of plants infested by pod borer in 51 DAP (%)[b]	0.5 – 11.1	4.3	2.5	5.8-28.8	14.5	6.2
4	Number of infested pods/plant (%)	3.9 – 20.3	10.1	4.3	6.1-41.3	19.6	7.9
5	Number of infested seeds/plant (%)	1.2 – 10.2	4.9	2.1	1.2-7.2	4.2	1.7

Note: [a] L1 = Controlled environment = *Maruca* was controlled with NPV 2g/l water; [a] L2 = Uncontrolled environment = *Maruca* was not controlled. [b] DAP = Days after planting; [c] SD = Standard deviation.

Based on the number of plants infested by borer in the L2 (without control) growing environment at 51 DAP, the resistance grouping was carried out according to the method by Chiang and Talekar (1980). Out of the 50 accessions tested, 5 accessions were considered medium resistant (MR), 23 accessions with low resistant (LR), 17 accessions susceptible (S) and 5 accessions highly susceptible (HS) (Fig 2). Fig 3 shows the symptoms of borer attack on mung bean pods and flowers characterized by pods and flowers being infested stick to one another.

The intensity of borer infestation in mungbean pods in L1 (controlled) environment ranged between 3.9 and 20.3% with average pod damage of 10.1%. While in L2 (uncontrolled) environment, pod damage was higher ranging between 6.1 and 41.3% with average pod damage 19.6% and significantly different from pod damage at L1 (Table 1). Based on the average percentage of pods affected in the 50 accessions tested, there were 5 accessions considered as MR, 22 accessions as LR, 22 accessions as S and 1 accession as HS (Fig 4).

Mung bean seeds also suffered due to borer attack, with the intensity of borer infestation in mung bean seeds in L1 (controlled) environment ranged between 1.2 and 10.2% with average pod damage was 2.1%. While in the L2 (uncontrolled) environment, seed damage was ranged between 1.2 and 7.2% with average pod damage was 4.2% and not significantly different from seed damage in L1 (Table 1). Damage to seeds was lower than damage to pods. Likewise, the interaction between the tested accessions and the growing environment did not show a significant difference.

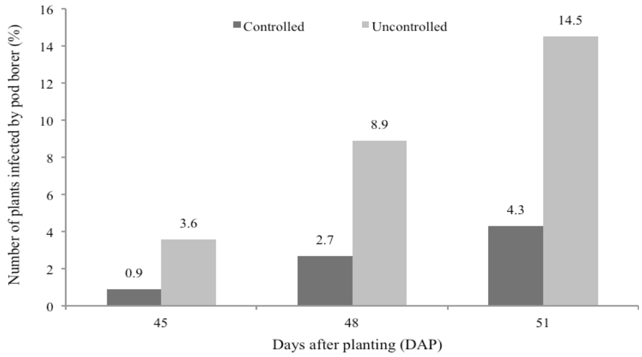

Fig 1: Number of plants infested by pod borer average of 50 mung bean accessions at 45, 48 and 51 days after planting (DAP) in two growing environments. Muneng 2018.

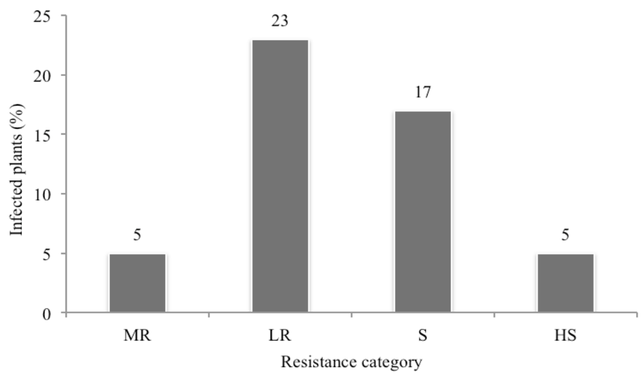

Fig 2: Distribution of resistance groupings of 50 mungbean accessions based on the number of plants infested by pod borer in the L2 (uncontrolled) environment at 51 DAP. Muneng. 2018. Note: MR = medium resistant; LR = low resistant; S = susceptible; and HS = highly susceptible.

Fig 3: Symptoms of borer *M. testulalis* caterpillar infested on mung bean pods and flowers.

Table 2: Eleven out of 50 mungbean accessions selected based on the low resistant (LR) to medium resistant (MR) categories on borer attacks. Muneng 2018.

No.	Accession code	Resistance Category [a] based on Plant infected at 51 DAP[b]	Pod infected	Seed infected
1.	MLGV 0054	LR	LR	LR
2.	MLGV 0115	LR	LR	MR
3.	MLGV 0306	LR	LR	MR
4.	MLGV 0320	LR	LR	LR
5.	MLGV 0902	LR	MR	LR
6.	MLGV 0977	MR	MR	LR
7.	MLGV 1003	MR	LR	LR
8.	MLGV 1017	LR	LR	LR
9.	MLGV 1027	LR	LR	MR
10.	MLGV 1044	LR	LR	LR
11.	MLGV 1062	LR	LR	LR

Note: [a] MR = moderately resistant; LR = resistant.
[b] DAP = Days after planting.

Classification of resistance based on the average percentage value of the number of seeds infested from the 50 accessions tested, there were 6 accessions considered as MR, 21 accessions as LR, 21 accessions as S and 2 accessions as HS (Fig 5).

Comparison of number of plant, pod/plant and seed/plant average of 50 mungbean accessions attacked by pod borer in two environments is presented in Fig 6. The low damage to seeds is probably due to the presence of pod skins which become barriers for borer to attack on the seeds.

Based on the percentage number of affected plants, the intensity of attacks on pods and seeds, 11 out of 50 mungbean germplasm accessions tested were selected having low resistant (LR) to moderately resistant (MR) categories on the attack of *M. testulalis* (Table 2). Soundararajan and Chitra (2017) reported that some of mungbean entries were found to be possessing moderate level of resistance to pod borer complex.

The different response of mungbean lines to pod borer attack could be influenced by various factors, including pod morphology (wall thickness of pods, number of pods/cluster and other pod characters). In addition to differences in pod morphology, the content of compounds or plant nutrients, pod walls can also affect the level of pod borer attack (Halder and Srinivasan, 2007 and 2011; Sunitha *et al.* 2008).

Number of pod/plant and seed weight

The average number of mung bean pods at L1 was 13.1 pods/plant, slightly higher than the number of pods at L2 (12.0 pods/plant) (Table 3). The lower number of pods at L2 was probably due to pod borer attack on the flowers, which resulted in the flowers being damaged or falled and pods failed to form, so the number of pods/plants was reduced. Traore *et al.* (2013) reported that *M. vitrata* infested the pea pods and flowers.

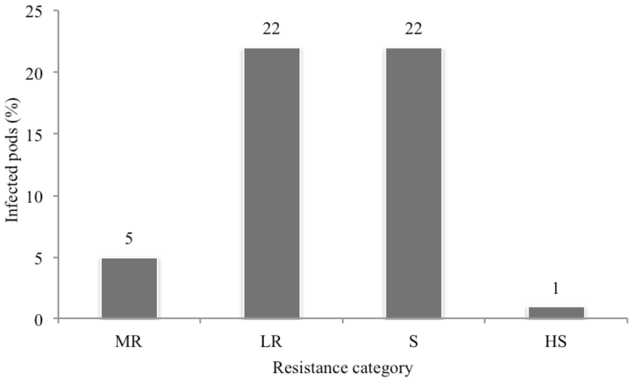

Fig 4: Distribution of resistance groupings of 50 mungbean germplasm accessions based on the number of pods attacked by pod borer. Muneng. DS 2018.

Note: MR = medium resistant; LR = low resistant; S = susceptible; and HS = highly susceptible.

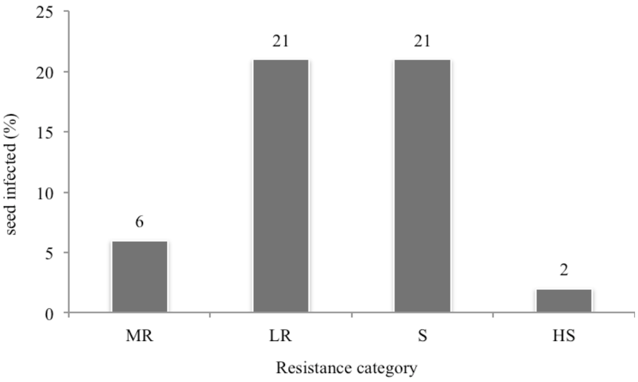

Fig 5: Distribution of resistance groupings of 50 mungbean accessions based on the number of seeds attacked by pod borer. Muneng, DS 2018.

Note: MR = medium resistant; LR = low resistant; S = susceptible; and HS = highly susceptible.

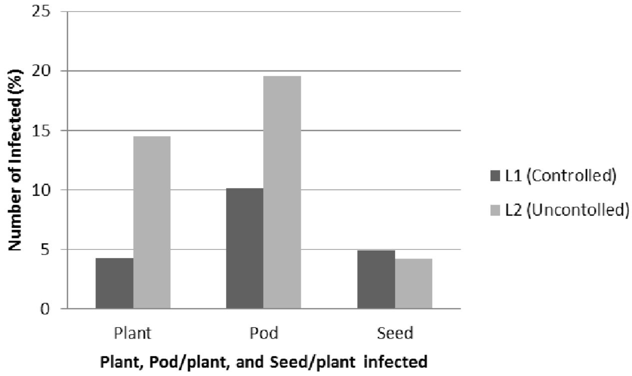

Fig 6: Number of plant, pod/plant and seed/plant average of 50 mungbean accessions attacked by pod borer in two environments. Muneng, DS 2018.

The dry seed weight of 50 accessions tested ranged from 306 to 476 g/3.2 m^2 with an average of 400.8 g/3.2 m^2 in a controlled environment (L1) and between 178 to 388 g/3.2 m^2 with an average of 302.2 g/3.2 m^2 in an uncontrolled

Table 3: Summary of 50 mungbean accessions on two characters observed related to pod borer evaluated in two environments. Muneng experimental station 2018.

No.	Characters observed	L1 Controlled Environment[a)]			L2 Uncontrolled Environment[a)]		
		Range of 50 accessions	Mean	SD [b)]	Range of 50 accessions	Mean	SD [b)]
1	Number of healthy pods/plant	9.0 - 26.5	13.1	3.1	8.4 - 18.1	12.0	2.2
2	Dry seed weight (g/plot)	306 - 476	400.8	37.1	178 - 388	302.2	49.1

Note: [a)] L1 = Ccontrolled environment = *Maruca* was controlled with NPV 2g/l water; [a)] L2 = Uncontrolled environment = *Maruca* was not controlled. [b)] SD = Standard deviation.

environment (L2) (Table 3). Based on the weight gain of dry seeds in a controlled environment (L1) and an uncontrolled environment (L2), the estimated yield loss of mung bean due to pod borer attack was 25% which was derived from comparing the average value in L1 of 400.8 g/3.2 m^2 with L2 of of 302.2 g/3.2 m^2 (Table 3). This finding agrees with the result reported by Umbarkar *et al*. (2011) that yield loss caused by pod borer complex in mungbean was estimated to 36.41%.

CONCLUSION

Eleven accessions gave a low resistant (LR) to moderately resistant (MR) categories responses against *M. testulalis* attacks. The pod damage from the eleven selected accessions was less than 15% under environmental conditions without control (L2). Control application (L1) reduced pod damage by 48.5% and increased mung bean seed yield by 25%, compared to without control (L2).

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