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FIELD EVALUATION OF DIFFERENT COFFEE CULTIVARS (COFFEA SP.) AGAINST THE INFESTATION OF COFFEE BERRY BORER (HYPOTHENEMUS HAMPEI FERRARI)

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A B S T R A C T

One of the major constraints to coffee production throughout the world is the damage caused by the Coffee Berry Borer (CBB), *Hypothenemus hampei* (Ferrari). The first report of the occurrence of CBB appears to be that of 1935 in Rathnapura District in Sri Lanka. It is now prevalent in all areas, at varying degree of damage to both Arabica and Robusta coffee. Damage on coffee berries bribes in heavy losses on economical production of coffee in developing countries, including Sri Lanka. The objective of this study was to identify the infestation level of CBB in six selected coffee cultivars and to assess the CBB populations in coffee fields. Six selected coffee cultivars were, Catimour, S4711, HDT of Arabica species and IMY, CCI, BS5 of Robusta species. The experiment was laid out in randomized complete block design, with six treatments and three blocks. Damage severity was recorded on fifty-four tagged coffee plants. Ten branches were selected from a coffee plant where each branch contained more than fifty berries. Data were collected on the same berry cluster, during three months at weekly intervals. Starting from zero damaged berries, the diameter of coffee berry was measured by using a Vernier calliper (0.1mm). Ninety coffee berries were randomly selected from each of Arabica and Robusta for measurements. The data were recorded continuously during the three months at weekly intervals. The results showed that there were significant CBB damage differences among the coffee cultivars. Among the selected cultivars BS5 was the least damage by CBB and HDT was the most susceptible cultivar and S4711 was also found to be susceptible but to a lesser extent. CBB populations were high in Arabica field than in Robusta field. When the diameter of the coffee berry increase, the level of infestation of CBB also increases.

Keywords: Coffee, Coffee Berry Borer, Coffee Berry Borer, *Hypothenemus hampei* Ferrari.

The genus *Coffea* (Rubiaceae) comprises 124 species (Davis *et al*., 2011), but only two of these are commercially traded: *C. arabica* L. and *C. canephora* Pierre ex A. Froehner (also referred colloquially to as "Robusta"). The significance of coffee in the world economy is staggering. It is grown in more than 10 million hectares in over 80 developing countries and approximately 20 million families depend on this plant for their subsistence (Hazekamp, 2001). For the years 2009 and 2010 coffee accounted for exports worth an estimated US$ 15.4 billion when some 93.4 million bags were shipped, with total coffee sector employment estimated at about 26 million people in 52 producing countries (International Coffee Organization, 2012).

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Export volume of coffee from Sri Lanka in 2014, was 56.98 MT valued at 29.81 million rupees (Ministry of Primary Industries, 2015). Arabica coffee grows best at high elevations, while Robusta is grown at lower elevations (Walyaro, 1977). Both species of *Coffea* can either be grown at full sun or under different levels of shade. Coffee growing can be considered as one of the most important agriculture occupations. It is grown in more than 10 million hectares in over 80 developing countries and approximately 20 million families depend on this plant for their subsistence (Rao *et al*., 2001). In 2009/10 coffee accounted for exports worth an estimated US$ 15.4 billion, when some 93.4 million bags were shipped, with total coffee sector employment estimated at about 26 million people in 52 producing countries (International coffee organization, 2012).

One of the major constraints to coffee production

throughout the world is the damage caused by the Coffee Berry Borer, *Hypothenemus hampei* (Ferrari) (Coleoptera: Curculionidae). This small beetle is endemic to Central Africa (Le Pelley, 1968), and can now be found throughout every coffee-producing region, with the exception of Nepal and Papua New Guinea. Adult females bore a hole in the coffee berry and lay their eggs in internal galleries, with larvae feeding on the coffee seed (Le Pelley, 1968). Feeding damage reduces yields, lowers the quality of the seed, and can result in the abscission of the berry. There is a 10:1 female to male sex ratio, most likely due to the presence of Wolbachia and once the insects moult into adults inside the berry, there is sibling mating, with the emerging females being already inseminated and ready to search for a berry in which they can start ovipositing. Thus, most of the life cycle is spent inside coffee berries, making this cryptic insect quite difficult to control both by chemical and non-chemical strategies. (Le Pelley, 1968). The first report of the occurrence of CBB in Sri Lanka appears to be that of in Rathnapura district in the year 1935. It is now prevalent in all areas, with varying degree of damage to both Arabica and Robusta. Crop losses in certain estates appear to be around 40% (Camargo, 2010). The problem is of great economic importance, perhaps even greater than leaf rust, especially because Robusta is also susceptible. Prevalence is independent of elevation and rainfall with high variation from planting to planting. Infestation is low in the plot kept free of weeds and fallen barriers. Infestation starts a month after anthesis. The life span of the female is about 156 days; this long span helps the insects to persist from one crop to the other (Camargo, 2010).

Eggs are laid in batches of 8-12 in cut cambers of the hardened maturing coffee bean. Each female lays 30-60 eggs over a period of 3-7 weeks, eggs hatch in 8-9 days. The larvae are legless, white brown heads. They feed by tunnelling in the tissues of the beans. The male larva develops through two instars in 15 days, and the female through there instars in 19 days. The naked pupal stage is passed in 7-8 days in the larval galleries. The adult female is about 2.5mm, long and the male about 1.6mm. Females fly from tree to tree to oviposit. The males are flightless and remain in the berry (Davis *et al*., 2011). The principle coffee producing and exporting countries in the world are Brazil, Vietnam, Colombia, Indonesia, Ethiopia, Honduras, India, Uganda, Guatemala, Mexico, Peru, Nicaragua, Costa Rica, Papua New Guinea (International Coffee Organization, 2012). Export volume of coffee from Sri Lanka in 2014, 56.98 MT and value 29.81 million rupees (Ministry of Primary Industries, 2015). The main objective of this study is to identify the infestation of Coffee Berry Borer on coffee cultivars. Specific objectives are to measure the damage severity of different cultivars of coffee under natural conditions, to evaluate the Berry Borer population on the species of Arabica and Robusta particularly under natural conditions and to find out the relationship between berry diameter and the level of infestation of Berry Borer.

The experiment was carried out from July to October 2017 at the Central Research Station of the Department of Export Agriculture; Matale (7-8 °N and 80-81°E) belongs to the WM3b agro-ecological region of Sri Lanka. Altitude of the location was 375m amsl. The study site consisted of reddish brown latosolic soil with average annual rainfall and the mean daily temperature of 1,400-3,300 mm and 18 to 25 °C, respectively. During the study period, the rainfall received was 1700 mm and the average temperature varied between 21.5 – 31.7 °C. The day time RH ranged from 55 to 80%. The coffee field which has been established in 2005 was selected for this experiment. This field experiment was done in a 10 years old coffee field, where no insecticides were applied. The coffee had been planted at a spacing of 2.5m × 2.5m. There were six coffee cultivars: Catimour, S4711, HDT of Arabica species and IMY, CCI, BS5 of Robusta species. These cultivars were diverse in many respects including the growth habit, yield and resistant to pest and disease. Randomized Complete Block Design, (RCBD) was used for this study with six treatments and three blocks.

T1 Catimor – Arabica
T2 HDT – Arabica
T3 S4711 – Arabica
T4 CCI – Robusta
T5 BS5 – Robusta
T6 IMY – Robusta

Damage severity was recorded at a weekly interval on 54 tagged coffee plants. 10 branches were selected for a coffee plant where each branch contained more than 50 berries. Starting from zero damage berries the number of damage berries were recorded until all the berries were fully matured and ripened.

Figure 1. Infected berry of Coffee Berry Borer.

The Berry Borer population was evaluated by placing 30 pheromone traps, 10m away from tagged plants on selected coffee plants on the field. The data was collected continuously during three months with one week interval (Baker, 1992). The Preferable berry diameter for the infestation was recorded continuously during 3 months with one week interval. Starting from zero damaged berries, the diameter of coffee berry was measured by using a Vernier calliper (0.02 mm). Thirty coffee berries were randomly selected and measured on Arabica and Robusta species each.

Table 1. Mean damage severity of different cultivars of coffee under natural field condition at weekly intervals (1 to 6 week).

Cultivars	Mean value of damage severity level					
	1st week	2nd week	3rd week	4th week	5th week	6th week
1	0.5 B	0.7 BC	1 BC	1.1 B	1.5 BC	1.8 BC
2	1.0 A	1.5 A	1.9 A	2.5 A	3.0 A	3.2 A
3	0.5 B	1.1 AB	1.5 AB	1.7 B	2.1 AB	2.5 AB
4	0.2 B	0.6 BC	0.9 BC	1.2 B	1.5 BC	1.7 BC
5	0.3 B	0.5 C	0.7 B	0.9 B	1.2 C	1.4 C
6	0.3 B	0.7 BC	1.1 BC	1.4 B	1.8 BC	2.2 BC

Means along the column with the same letter are not significantly different at the 95% probability level.

Table 2. Mean damage severity of different cultivars of coffee under natural field condition at weekly intervals (1 to 6 week). Means along the column with the same letter are not significantly different at the 95% probability level.

Cultivars	Mean value of damage severity level					
	7th week	8th week	9th week	10th week	11th week	12th week
1	2.0 BC	2.5 BC	3.2 BC	5.0 BC	5.6 BC	6.6 BC
2	3.4 A	4.0 A	5.3 A	7.0 A	8.0 A	8.7 A
3	2.7AB	3.2 AB	4.3 AB	5.8 AB	7.0 AB	7.8 AB
4	1.8 C	2.2 BC	3.1 C	4.6 BC	6 BC	6.8 BC
5	1.7 C	2.0 C	2.7 C	3.8 C	5 C	6 C
6	2.5 BC	3.0 BC	3.4 BC	4.7 BC	5.6 BC	6.7 BC

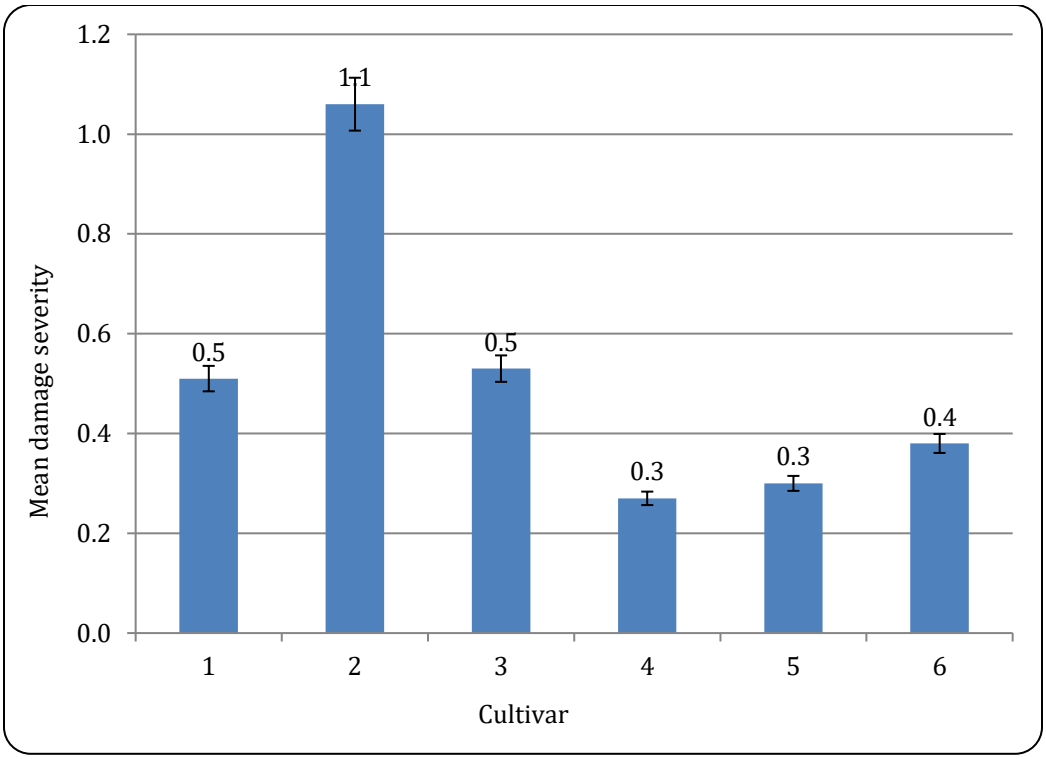


Figure 1. Mean damage severity per cultivar at 1st week.

According to the analysis cultivar, HDT was more significantly affected by the Coffee Berry Borer on the 1st week.

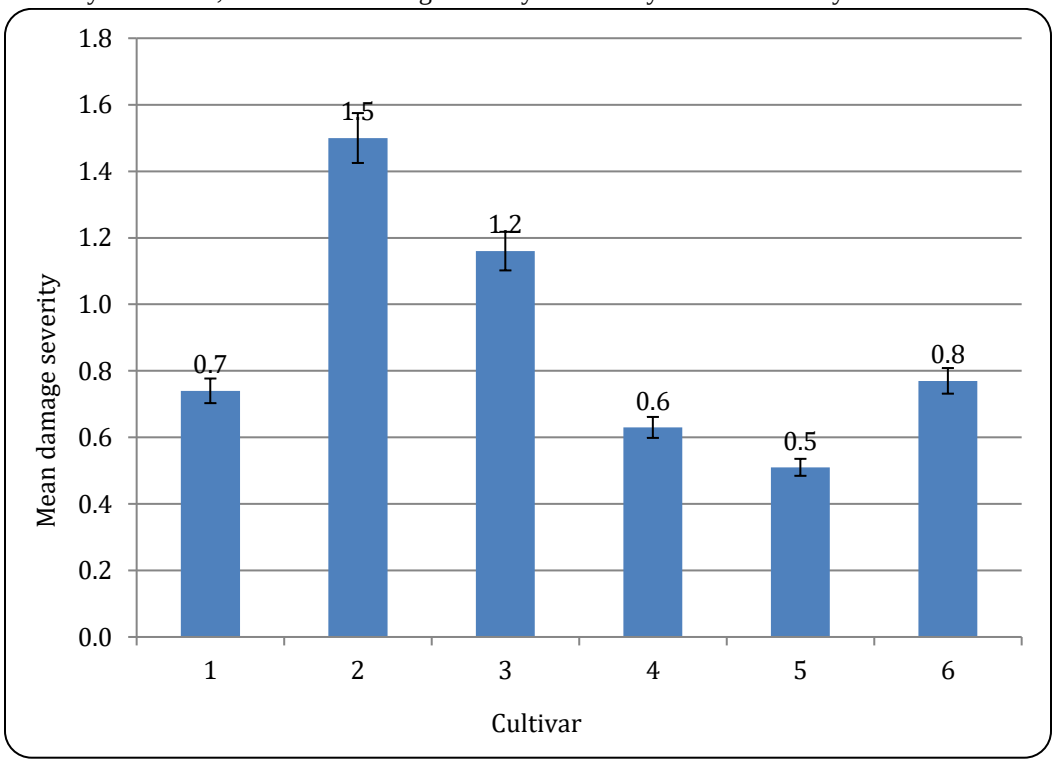


Figure 2. Mean damage severity per cultivar at 2nd week.

According to the analysis cultivar, HDT was more significantly affected by the Coffee Berry Borer and cultivar BS5 was more significantly resistant to Coffee Berry Borer attack on the second week.

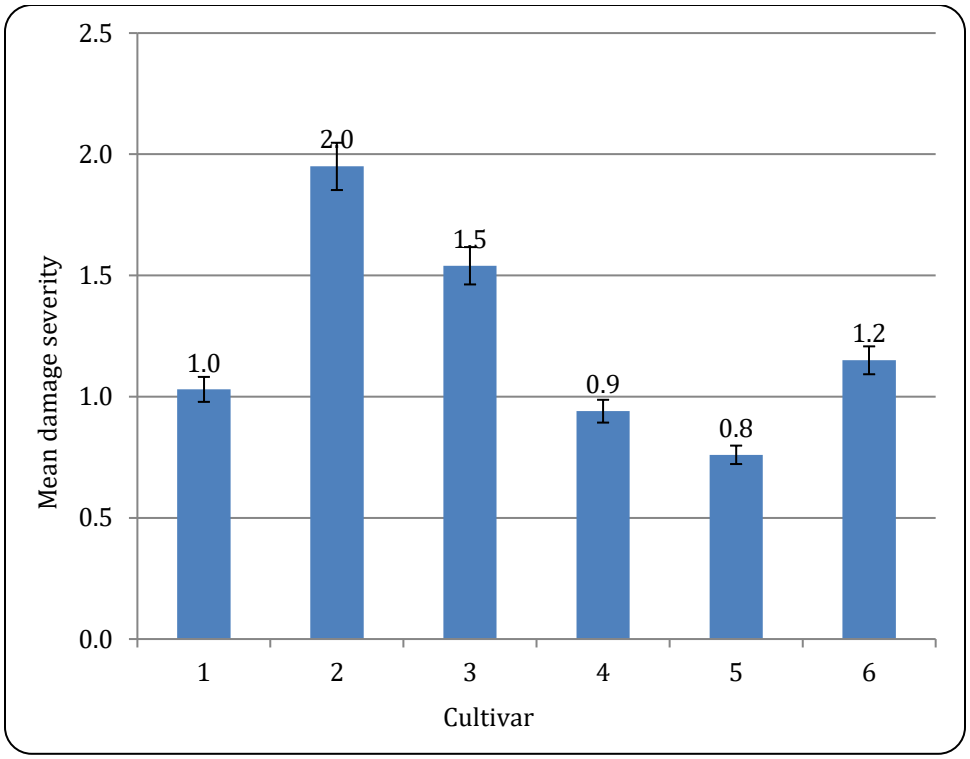


Figure 3. Mean damage severity per cultivar at 3rd week.

According to the analysis cultivar, HDT was more significantly affected by the Coffee Berry Borer and cultivar BS5 was more significantly resistant to Coffee Berry Borer attack on the third week.

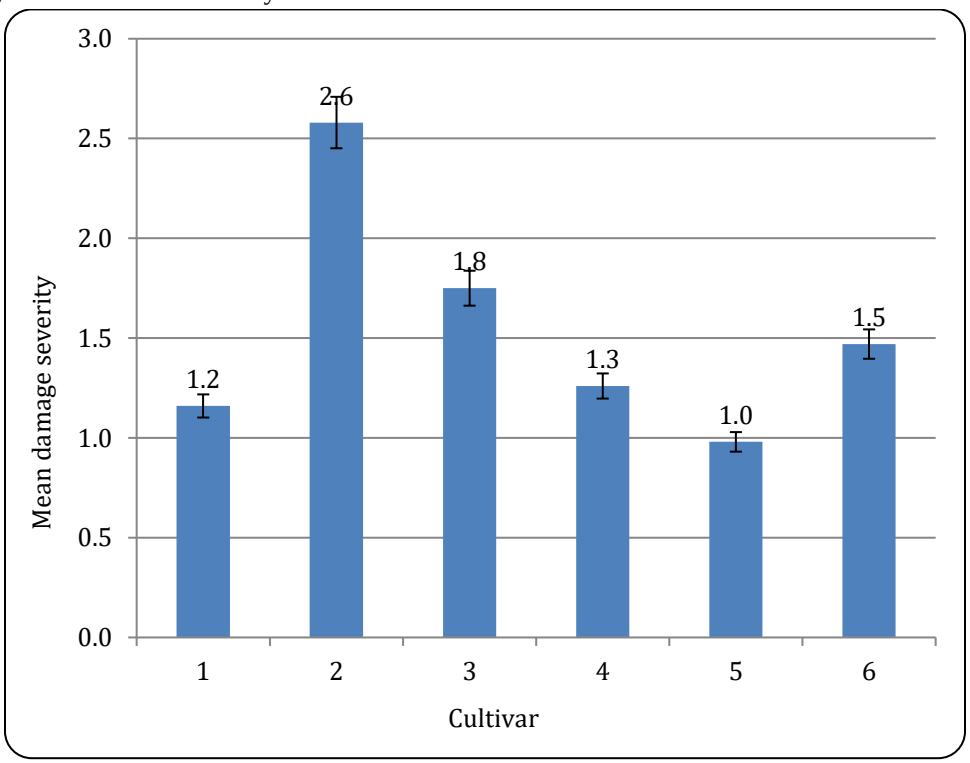


Figure 4. Mean damage severity per cultivar at 4th week.

According to the analysis cultivar, HDT was more significantly affected by the Coffee Berry Borer on fourth week.

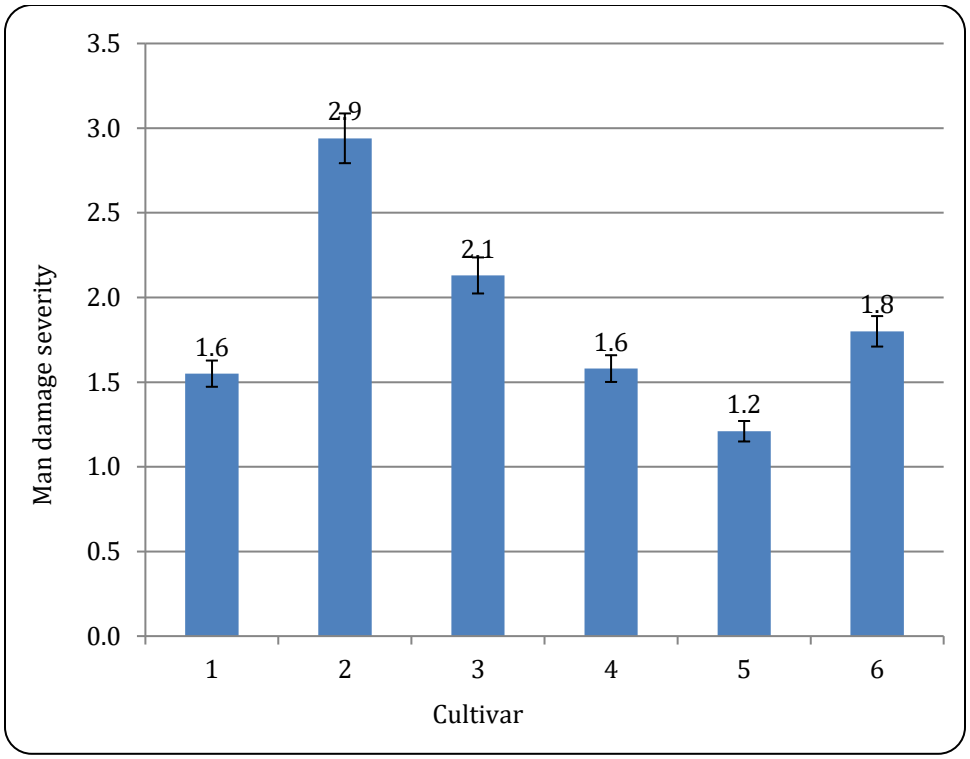


Figure 5: Mean damage severity per cultivar at 5th week.

According to the analysis cultivar, HDT was more significantly affected by the Coffee Berry Borer and cultivar BS5 was more significantly resistant to Coffee Berry Borer attack on the fifth week.

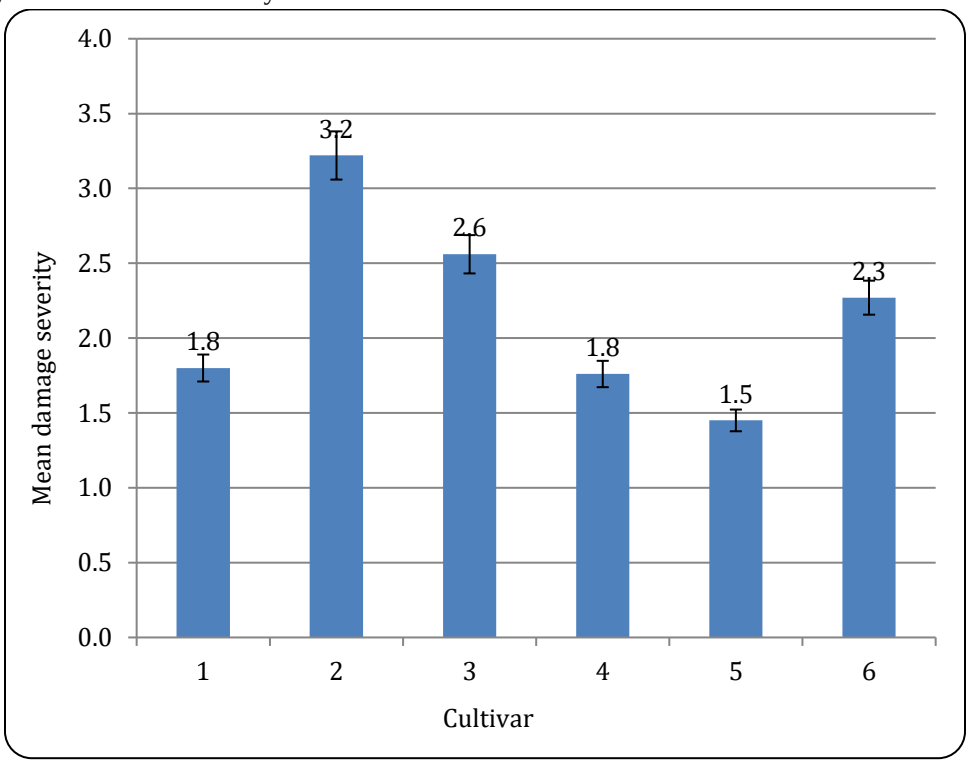


Figure 6. Mean damage severity per cultivar at 6th week.

According to the analysis cultivar, HDT was more significantly affected by the Coffee Berry Borer and cultivar BS5 was more significantly resistant to Coffee Berry Borer attack on the sixth week.

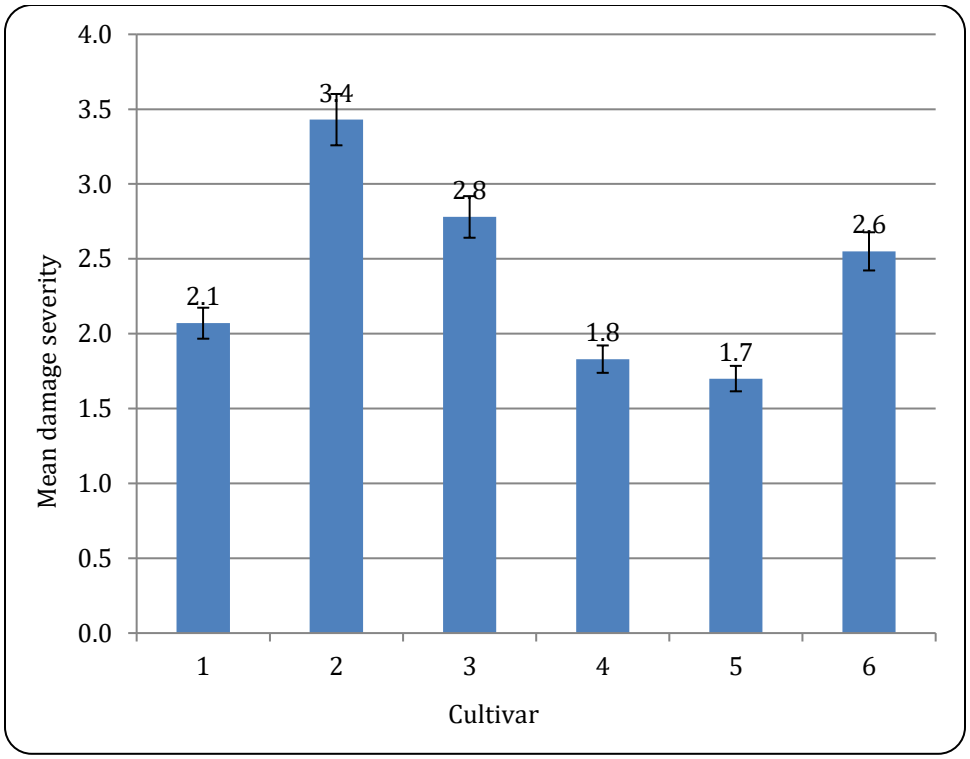


Figure 7. Mean damage severity per cultivar at 7th week.

According to the analysis cultivar, HDT was more significantly affected by the Coffee Berry Borer and cultivar BS5 was more significantly resistant to Coffee Berry Borer attack on the seventh week.

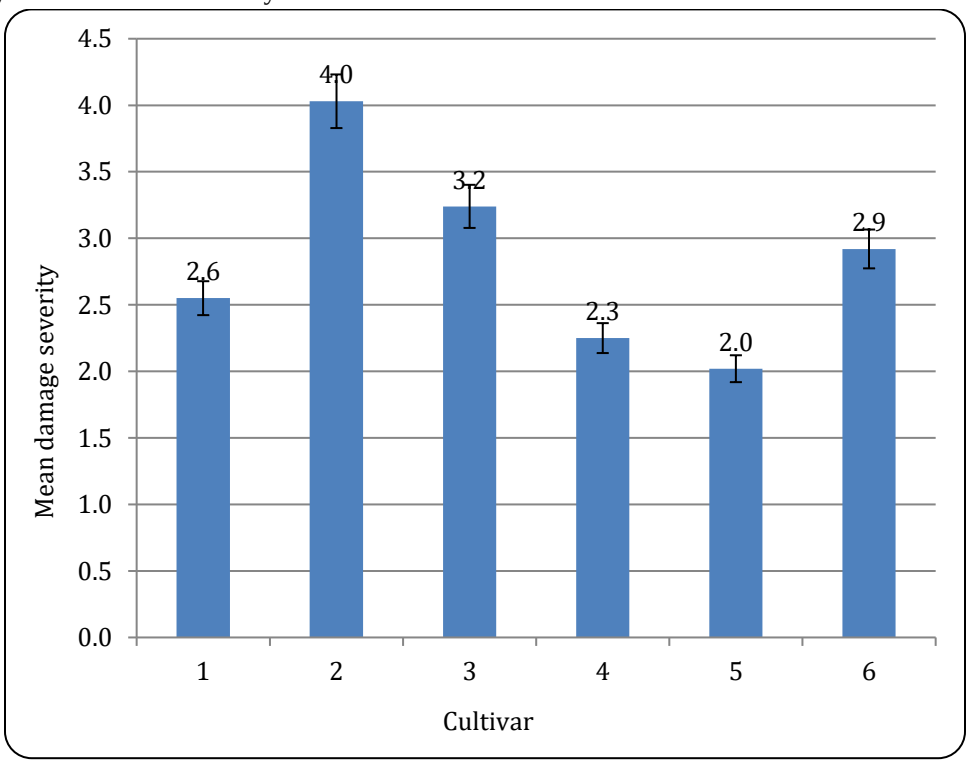


Figure 8. Mean damage severity per cultivar at 8th week.

According to the analysis cultivar, HDT was more significantly affected by the Coffee Berry Borer and cultivar BS5 was more significantly resistant to Coffee Berry Borer attack on the eighth week.

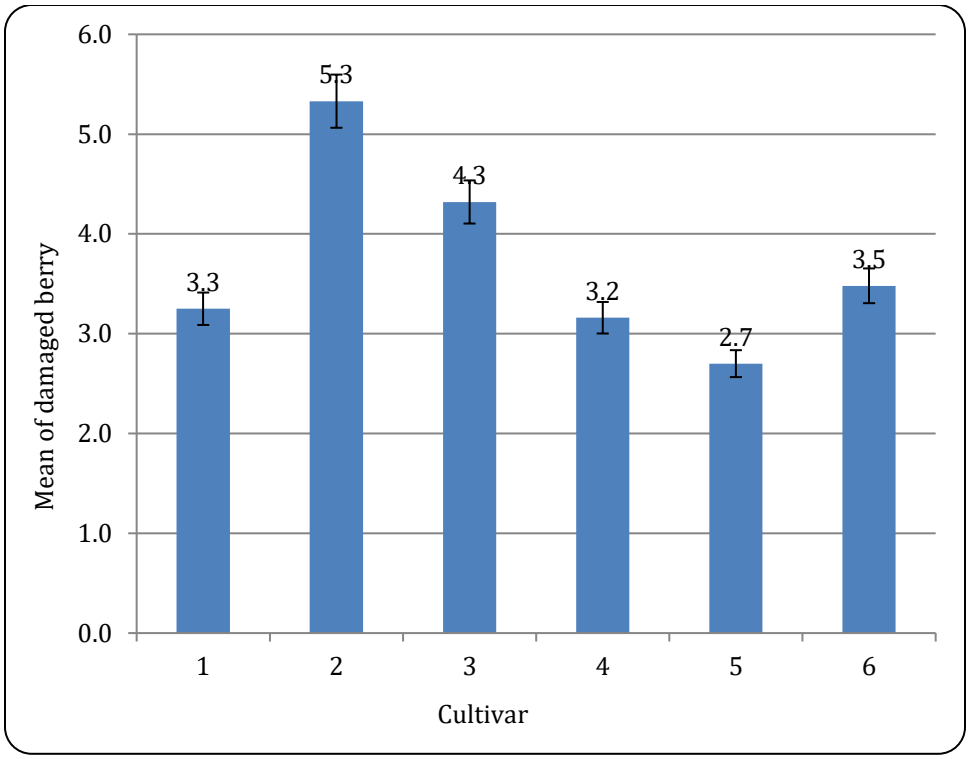


Figure 9. Mean damage severity per cultivar at ninth week.

According to the analysis cultivar, HDT was more significantly affected by the Coffee Berry borer and cultivar BS5 was more significantly resistant to Coffee Berry Borer attack on ninth week.

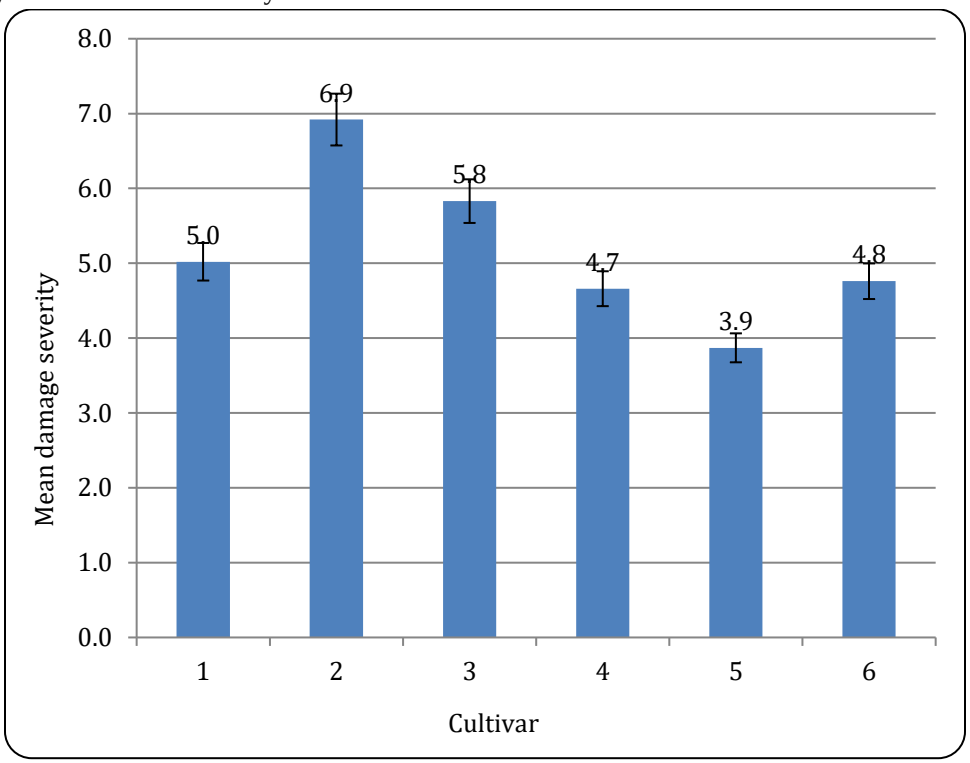


Figure 10. Mean damage severity per cultivar at 10th week.

According to the analysis cultivar, HDT is more significantly affected by the coffee berry borer and cultivar BS5 is more significantly resistant to Coffee berry borer attack on the tenth week.

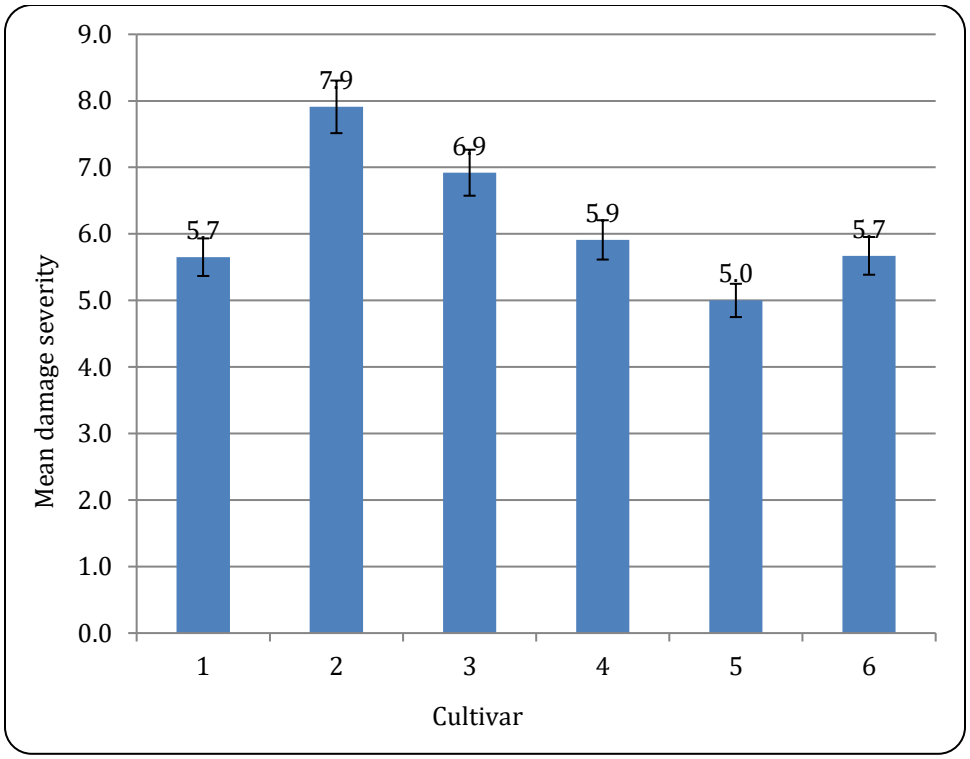


Figure 11. Mean damage severity per cultivar at 11th week.

According to the analysis cultivar, HDT is more significantly affected by the coffee berry borer and cultivar BS5 is more significantly resistant to Coffee berry borer attack on the eleventh week.

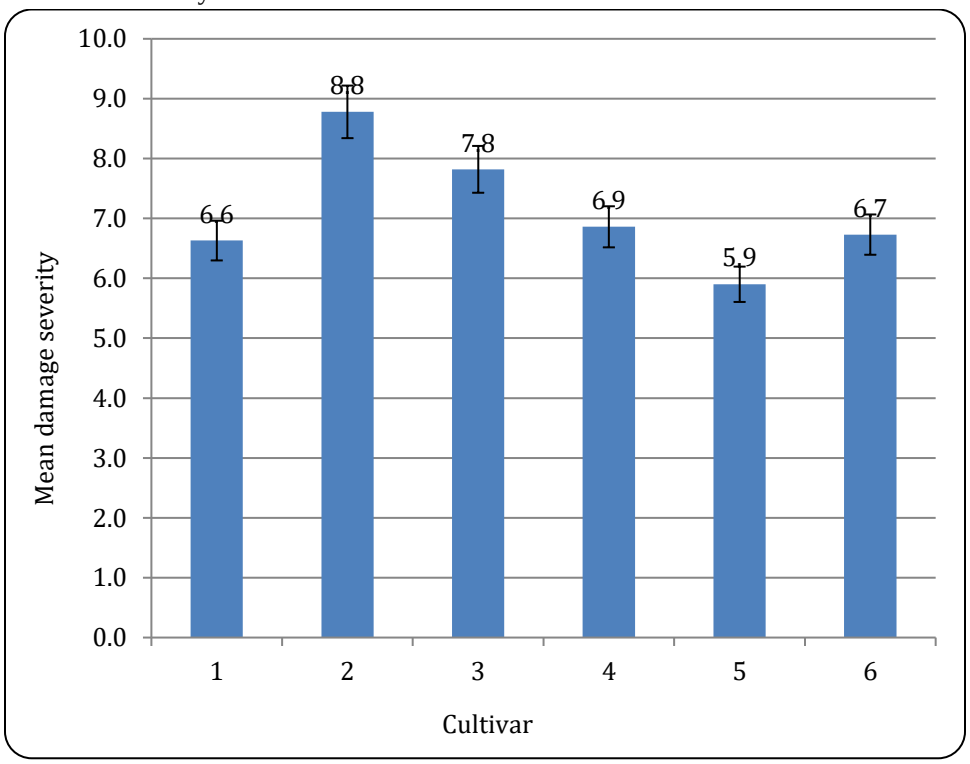


Figure 12. Mean damage severity per cultivar at 12th week.

According to the analysis cultivar, HDT is more significantly affected by the Coffee Berry Borer and cultivar BS5 is more significantly resistant to Coffee Berry Borer attack on the twelfth week.

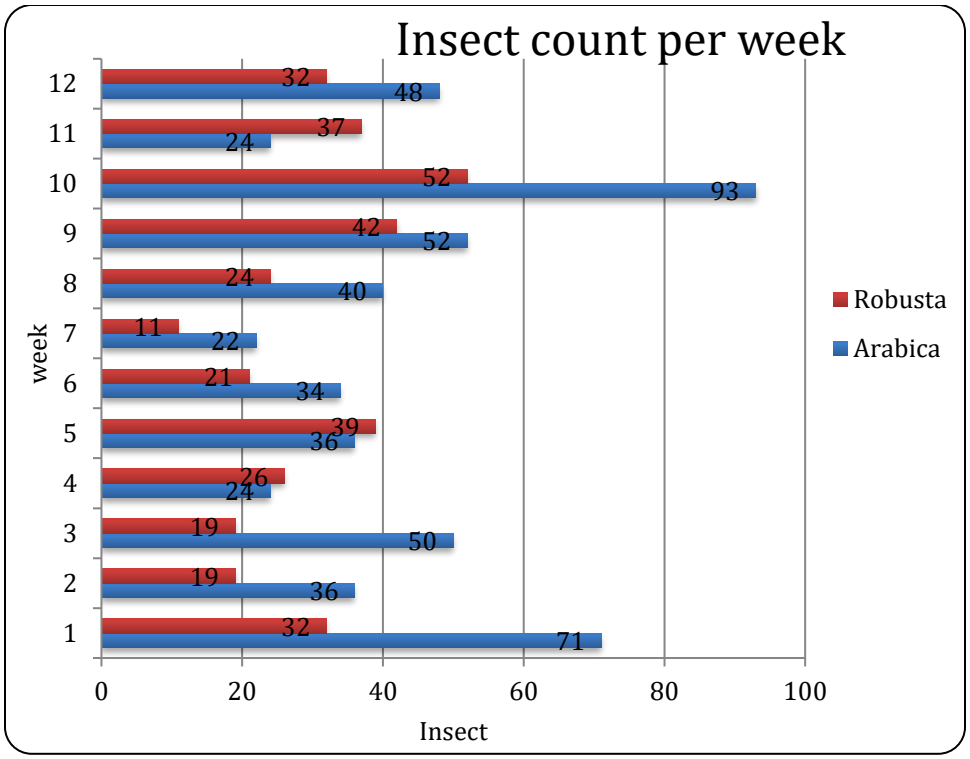
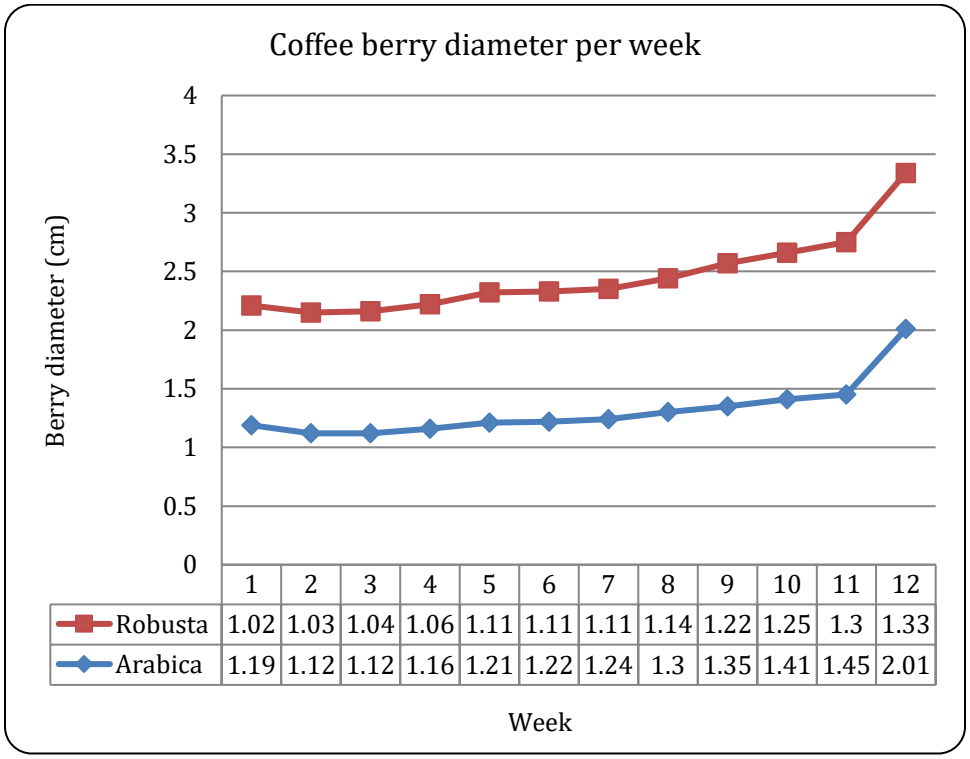


Figure 13. Berry Borer population on Coffee field.

The Coffee Berry Borer population was high in Arabica field but there were some up and downs on the count as shown on the above figure. The insect population was low in the Robusta field but on the fourth and fifth week it was a little higher than that of Arabica field.



	1	2	3	4	5	6	7	8	9	10	11	12
Robusta	1.02	1.03	1.04	1.06	1.11	1.11	1.11	1.14	1.22	1.25	1.3	1.33
Arabica	1.19	1.12	1.12	1.16	1.21	1.22	1.24	1.3	1.35	1.41	1.45	2.01

Figure 14. Preferable berry diameter for the infestation of Coffee Berry Borer.

Gradual increase in berry diameter from the first week to twelfth week in both Arabica and Robusta species. Arabica species berry diameter is higher than that of Robusta species for these twelfth weeks. Previous studies reported that Robusta species resistance to Coffee Berry Borer than that of Arabica species (Vega *et al*., 1999). In this study also the BS5 was resistance to CBB which belongs to Robusta species and HDT was most susceptible to CBB which belongs to Arabica species.

Among the selected cultivars BS5 was the least damage by CBB and HDT was the most susceptible cultivar and S4711 was also found to be susceptible but to a lesser extent. Berry Borer population is comparatively higher on Arabica field than that of Robusta field. When the diameter of the coffee berry increases, the level of infestation of Coffee Berry Borer also increases.

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