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Nutrient Components and Relation with Resistance Potential of Field Pea Genotypes Seeds to 'Callosobruchus chinensis L.' Under Laboratory Conditions

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Abstract: Field pea (*Pisum sativum* L.) is among the major food crops grown globally for its high protein content. However there is no detailed nutrient composition profile and recently challenged with a storage pest, *Callosobruchus chinensis* L. This study was carried out to know the nutrient composition and quantify the damage caused by the pest and identify the sources of resistance in the genotypes in Ethiopia. The study was conducted at Kulumsa Agricultural Research Center (KARC) in Ethiopia, during 2019. Nutrients were estimated in laboratory analysis and callosobruchus chinensis L. was used to challenge 26 field pea genotypes under no choice condition, in the laboratory. Results showed a significant differences (p<0.01) in all measured traits. However, the highest nutrient composition and less susceptibility values were recorded by the *Pisum var. abyssinicum* landraces (collections) number 1 to 10 those are mostly grey and grey/green seed color while the lowest nutrient composition and highest susceptibility values were obtained from the *pisum sativum* L. those are improved, introduced and crossed genotypes number 11 to 26 with white, creamy, dun, light green, mottled and brown. Within this fpcoll-30/07 had the lowest SI (4.06), followed by fpcoll-42/07 (4.47), fpcoll-2/07 (4.77) and fpcoll-31/07 (4.94) whereas Burkitu, Tegegnech and PDFPT P-313 MILKY had the highest SI (>10) (Table 4). Genotypes; fpcoll-1/07, fpcoll-2/07, fpcoll-28/07, fpcoll-29/07, fpcoll-30/07, fpcoll-31/07, fpcoll-40/07, fpcoll-41/07, fpcoll-42/07/ had high values (ppm) for; ca, k, mg, and zn, whereas all improved, introduced crossed line of considered field peal genotypes had low values (ppm) for the above nutrients. In general there is a possibility that promising field pea genotypes in both high nutrient composition and less susceptibility could be used in a future breeding system.

Keywords: *Collosobruchus chinensis* L., Field Pea, Traits and Genotypes

1. Introduction

Field pea (*Pisum sativum* L.) is a diploid species (2n=2x=14) belongs to the family Fabaceae (sub-family Papilionaceae) [5] and a well-known crops in Ethiopia. It is an annual herbaceous legume adapted to cool moist climate with moderate temperatures found in various regions of Ethiopia [14].

Field pea is a cheap source of protein (20-27% crude protein) for humans [20]. It is rich in nutrients like Fe, Zn, Ca, and Mg. It plays a significant role in soil fertility restoration due to its nitrogen fixing ability and serves as a break crop suitable for rotation to minimize the negative impact of cereal based mono-cropping [21, 16]. Specially, it serves as staple food for millions of people and also used as a source of income for the farmers and foreign currency for the country [13, 32].

Presently, the crop is the fourth most important pulse crop in Ethiopia that accounts over 12.7% of the total grain legume production [8, 7]. The national average grain production of field pea was 1.64 tons per hectare [8], that's low as compared to the World production of 1.99 tons per hectare [11] because of mainly constrained by several biotic and abiotic factors. Among the biotic factors, adzuki bean beetle (*Callosobruchus chinensis* L.) was a devastating insect pest at storage levels [15] with losses that extends up to 25 to 40% annually in the sub-Saharan Africa [24]. These losses

can be in terms of quantity, quality, nutritional and economic value [19]. The seeds of legumes, once damaged by storage insects, are no longer fit for planting (due to poor germination) or for food or feed (due to spoilage and bad smell) [4]. In other side Micronutrient malnutrition, which is also known as hidden hunger, can affects more than half of the world's population, with most being women and pre-school children in Asia and Africa.

Therefore, this study was focus on evaluation of different field pea genotypes seeds to adzuki bean beetles resistance and its relations with mineral content of the considered genotypes, since cultivars of host seeds shows significantly vary in susceptibility levels to insect attack [25], that has been used in genetic improvement of the hosts of various crops for resistance that plays a countless role for effective storage insect pest management practices [31, 34].

2. Material and Methods

Table 1. Location and descriptions of locations.

Location Kulumsa	Geographic position		Altitude	Temperature (°C)		Rain fall (mm)	Relative humidity
	Latitude	Longitude		Min	Max		
	08°00'02"N	39°09'11"E	2210	10	22.4	811	60.6

*** ° - degree and °C – degree centigrade

Sources: http://www.eiar.gov.et

3. Experimental Materials

Table 2. List of field pea accession used in the study.

SN	Accessions	Source/Locality	Altitude	Zone	Year of released/G. C	Region
1	fpcoll-1/07	Metatera	1600	North Wollo	-	Amhara
2	fpcoll-2/07	Metatera	1900	North Wollo	-	Amhara
3	fpcoll-28/07	Dikowuha	1878	North Wollo	-	Amhara
4	fpcoll-29/07	Dikowuha	1870	North Wollo	-	Amhara
5	fpcoll-30/07	Dikowuha	1878	North Wollo	-	Amhara
6	fpcoll-31/07	Kidana	1450	South Tigray	-	Tigray
7	fpcoll-40/07	Daguyat	2500	South Tigray	-	Tigray
8	fpcoll-41/07	Kidana	1450	South Tigray	-	Tigray
9	fpcoll-42/07	Hiziba	2400	South Tigray	-	Tigray
10	fpcoll-43/07	Endamohoni	2200	South Tigray	-	Tigray
11	Mahandarfer	HARC/KARC	-	-	1979	NR
12	Burkitu	HARC/KARC	-	-	2009	NR
13	Adi	HARC/KARC	-	-	1995	NR
14	Tegegnech	HARC/KARC	-	-	1994	NR
15	Markos	HARC/KARC	-	-	1995	NR
16	Gume	HARC/KARC	-	-	2006	NR
17	Bursa	HARC/KARC	-	-	2015	NR
18	Bilalo	HARC/KARC	-	-	2010	NR
19	Letu	HARC/KARC	-	-	2010	NR
20	PDFPT p-313-010	ICARDA	-	-	-	Introduced
21	FP PDFPT P-313-045	ICARDA	-	-	-	Introduced
22	PDFPT p-313-090	ICARDA	-	-	-	Introduced
23	PDFPT p-313-046	ICARDA	-	-	-	Introduced
24	PDFPT p-313 MILKY	ICARDA	-	-	-	Introduced
25	EH-08086-1	HARC/KARC	-	-	-	CL
26	EK-08021-5	HARC/KARC	-	-	-	CL

Key; NR-Nationally released, CL-Crossed lines

4. Experimental Field Layout and Management

Treatments Seeds of field pea genotypes were grown in 2019/20 main cropping season. The genotypes were laid independently on their plot areas of (4m x 0.8m) with 80 seeds per each four rows. The spacing between rows and plants were 20cm and 5cm. Standard recommendation 100kg/ha DAP were used. All agronomic practices were applied as per its recommendation. Harvested seeds of each genotype were cleaned manually from foreign materials and adjusted to 9-10% moisture contents and disinfected in a deep freeze at about -20°C for a month prior to the study to eliminate any pre-storage infestation (eggs, larvae and adult bruchids) [22, 6].

Mass-rearing was conducted at Kulumsa Agricultural Research Center, Entomology Laboratory. The procedures based on [21, 6, 37] recommendation on susceptible chickpea variety 'Shasho'. The beetle were introduced to each 4 kg of

seeds from the susceptible variety and kept at ambient temperature and relative humidity for seven days to allow for ovi-position. The parent insects were sieved out after seven days. Then the new emerged progeny was used for re-culturing and kept again at optimum condition within the susceptible variety and removed after seven days. This re-culturing was continued and after the enough number of a new emerged insect was obtained, i.e. 1-2 day old adult, unsexed insects were used for the different experiments.

5. Experimental Design and Infestation

The experiment was conducted under room temperature and relative humidity in a randomized complete block design with 3 replications. Since the harvested seed was cleaned and kept in cold room for one moth and disaffected from any of the insect egg. Two hundred seeds of each genotype were allocated per experimental unit (a plastic jar of 250 ml; 6 cm x 7 cm). Each jar considered as an experimental unit. The field pea genotypes were assigned to jars at random within each block. Fourteen 1-2 days old unsexed adults of Adzuki bean beetles were collected from the maintained culture and randomly selected and released in each jar. The male to female ratio in this insect was 1:1 [26]; it is assumed that each jar was received 7 males and 7 female with a total of fourteen (14) insect in a single jar [22, 6, 37]. Serration antennae described by [18] used as a parameter to identify the sex. For oviposit ion, adults were kept in the jars for 7 days after introduction and removed from the jars. The plastic jars containing seeds were inspected for the emergence of first progeny every day. After emergence of the first progeny is completed, the first progeny were removed from the jars for evaluation of the level of attack and loss incurred by the first progeny. Temperature and relative humidity of the room were recorded daily with the help of thermo-hygrometer until the end of the experiment to perceive the daily fluctuation.

6. Some Physicochemical Properties of Field Pea

The chemicals, standards, reagents and high purity solvents used for digestion, extraction and analytical determination were analytical grades; distilled water was used for sample and reagent preparation. The moisture content of field pea was determined according to the method of [1]. An empty flat-bottomed aluminum dish was sterilized and weighed. The sample (5g) was placed in the pre weighed dish and placed in an oven at 75°C. The dish was removed after 3 hours and cooled in desiccator for 1 hour and weighed. The moisture content was calculated. Ash percentage was determined by gravimetric 6400252 methods as described by [1] using a muffle furnace capable of maintaining temperatures of 550°C. An empty crucible was weighed, and then 10g of field pea were weighed in it by using sensitive balance. The sample in crucible was place in muffle furnace

at 550°C for three hours until grey ash was obtained. The crucible was removed from furnace to desiccators to cool, and then weighed. Total N was determined by distillation of an aliquot from the digest with NaOH, collecting the distillate in boric acid and titrating with 0.01N H_2SO_4 to the end point of the mixed indicator. The kjeldahl procedure was based on the principle that by treating plant material with concentrated sulfuric acid it was oxidized and nitrogen in the plant material was being converted into ammonium sulfate during the oxidation. The ammonia liberated in the distillation process with NaOH is trapped by the acid. The ammonia was adsorbed in the form of NH_4^+ ion in boric acid and back titrated with standard H_2SO_4. The nitrogen content estimated by the Kjeldahl method and was converted to protein content by using the conversion factor 6.25 [1]. Determination of phosphorus was carried out on the digest aliquot obtained through wet digestion. The phosphorus in the solution was determined Uv-Visible spectrophotometry by using moly date and met vanadate for color development. The reading was made at 660nm wavelength. Determination of phosphorus was carried out on the digest aliquot obtained through wet digestion. The phosphorus in the solution was determined Uv-Visible spectrophotometry by using moly date and met vanadate for color development. The reading was made at 660nm wavelength. The calibration curve was prepared on graph paper, with absorbance on the X-axis and concentration on the Y-axis. Plot the standards and read off the concentrations of the samples in ppm from the graph. The rest mineral concentrations were determined by atomic absorption spectrophotometers (AAS). The solution detection limit was 5 μg L^{-1}, Fe and Zn, 30 μgL^{-1} for K, Ca and Mg, 80μgL–1 for P. Analytical quality assurance was accomplished using authentic calibration standards.

7. Data Collected

Based on the total number of seeds and insect based traits the following data were recorded from each pot with their respective orders.

Total number of eggs (TNE): Total number of eggs laid on the surface of seeds of each genotype was counted on a daily basis started from the 4th day to the 14th day of infestation and records were taken from each treatment.

Days to adult emergence (DAE): The number of days required to adult emerges was recorded on a daily basis start from the 20th day to the 32th day of infestation until adult emerged.

Number of adults emerged (NAE): Total number of emerged adults from each genotype was counted on a daily basis started from the 22th to the day to 32th day of infestation.

The percentage of seed damage (PSD): The percent damage of each genotype was calculated by separating healthy grains (without holes) from the sieved samples and used for percent damage calculations using the formula described by [23].

$$Percentage\ of\ seed\ damage = \frac{Nds}{Tns} x100$$

Where Nds=number of damaged seed, Tns=total number of seeds

Percentage of adult recovery (PAR): The actual number of adults that emerged compared with the actual number of eggs laid on the surface of seeds.

Thousand seed weight in gram (TSW): Cleaned grains sample was taken after adjusted standard moisture content (10%) from each genotype and 1000-grain seeds were counted from each sample grown under the same conditions.

Proportion of Seed coat by weight in percent (PSC): Seed coat weight as percent of total seed weight of the same genotypes grown under the same conditions were taken.

Germination percentage; Number of germinated seed (Gs) over Total number seed (Tns)

$$Germination\ percentage = \frac{Gs}{Tns} x100$$

$$Weight\ loss\ (\%) = \frac{(UNd)-(DNu)}{U(Nd+Nu)} \times 100$$

Where U=Weight of undamaged grains Nu=number of undamaged grains D=Weight of Damaged grains Nd=Number of damaged grains

$$Moisture\ (\%) = \frac{Weight\ of\ fresh\ field\ pea - Weight\ of\ dried\ fieldpea\ sample}{Weight\ of\ fresh\ fieldpea} \times 100\%$$

Ash (%)

Ash percentage was determined by gravimetric 6400252 methods as described by [1].

$$Ash\ content\ (\%) = \frac{W2 - W1}{W3} \times 100\%$$

Where: W_1=weight of empty crucible
W_2=weight of crucible with sample
W_3=weight of sample
Total Nitrogen (%)

The percent of total nitrogen was calculated by using the following formula:

$$Nitrogen(\%) = \frac{(a-b)\ x\ N\ x\ V\ x\ 0.014\ x\ 100\ x\ mcf}{S}$$

Where, a=ml of H_2SO_4 required for titration of sample.
b=ml of H_2SO_4 required for titration of blank.
s=air-dry sample weight in grams.
N=normality of H_2SO_4 (0.01N).
0.014=meq weight of nitrogen in grams.
mcf=moisture correction factor.
Protein Content (%)

Protein content was determined using Kjeldahl method. The nitrogen content estimated by the Kjeldahl method and was converted to protein content by using the conversion factor 6.25 [1].

Available phosphorus

Plot the standards and read off the concentrations of the samples in ppm from the graph.

Dobie susceptibility index (DSI): Susceptibility index calculated Dobie (1977) using the formula:

$$SI = \frac{Log\ Y}{T} \times 100$$

Where SI=susceptibility index, Y=number of F1 emerged adults, T=mean developmental periods (days), estimated as the time from the middle of ovipositor period to the 50% emergence of the F1 progeny. The values of the susceptibility indices were used to rank genotype susceptibility to the bruchids into five categories according to [28] as follows:

i. Genotypes with values from 0.0-2.5 were considered resistant genotypes (R).

ii. Genotypes with values from 2.6-5.0 were considered moderately resistant (MR).

iii. Genotypes with values from 5.1-7.5 were considered moderately susceptible (MS).

iv. Genotypes with values from 7.6-10.0 were considered susceptible (S).

v. Genotypes with values greater than 10.0 were considered highly susceptible (HS).

Moisture content (%)

The moisture content of field pea was determined according to the method of [1].

$$P\ (ppm) = \frac{C * V1 * V2 * mcf}{S * A}$$

Where: C=P concentration in sample digest read from the curve, ppm.
V_1=Volume of the digest (100ml).
V_2=Volume of the dilution.
S=Weight of the plant material calcinated in g (1).
A=Aliquot (5ml).
mcf=moisture correction factor.

8. Statistical Data Analysis

Analysis of variance (ANOVA) through SAS software for seed and insect traits and partially also mineral analysis were done through descriptive statistics.

9. Result and Discussion

Comparative significant difference (p<0.01) was recorded among the tested field pea genotypes that may be due to a sufficient genetic variation among the genotypes for the traits considered (table 3). This result suggest that the relative resistance to adzuki bean beetle in the studied field pea genotypes could be due to the presence of antixenosis which is more skewed to the considered seed traits and antibiosis resistance mechanism specifically due to biochemical defenses mechanisms in the seeds, which might have acted as a deterrent to oviposition, adult developmental and weight

loss in those genotypes. In line with this, a legume crops with small-sized seeds wrinkled, hardness, rough, almost spiny seed coat and different chemical constituents were showed more resistance to bruchids [3, 22, 33].

Table 3. Mean square of combined analysis for selected parameter used to assess field pea genotypes exposed to infestation by adzuki bean beetles in Ethiopia.

Mean squares															
Sources of variation	NE	DAE	NA	AR (%)	MN HPS	TSW	PSC (%)	PSD (%)	PSWL (%)	SI	TN (%)	P (%)	K (ppm)	Ca (ppm)	P (ppm)
Replication	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Genotype (G)	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
%CV	8	5.7	11	13	12.8	0.9	2.6	23	14.7	7.3	8.3	6	3.7	11.8	7.7

**=highly significant (P <0.01), *=significant (P<0.05) and NS=non-significant (P>0.05). 1NE=total number of egg, DAE=days to adult emergence, NA=number of adults emerged, AR=adult recovery, MNHPS=mean number of holes per seed, TSW=Thousand seed weight, PSC=proportion of seed coat weight, PSD=percentage of seeds damage, PSWL=percentage of seed weight loss, SI=susceptibility index, TN=total nitrogen, K=potassium, Ca=calcium, P=phosphorus, CV=coefficient of variation

10. Effect of Genotype on the Level of Resistance in Field Pea

Comparative difference was recorded among the tested genotypes that may be due to a sufficient genetic variation among the genotypes for the traits considered in this study even if the interrelations between the traits revealed strong associations in a number of cases both in positive and negative directions. In this study result, most of the lowest values were recorded by the *Pisum var. abyssinicum* landraces (No. 1-10) mostly grey and grey/green seed color while the highest values were obtained from the *pisum sativum* L. those are improved, introduced and crossed genotypes (No. 11-26) with white, creamy, dun, light green, mottled and brown. In this finding seed coat color indicated the variability in seed resistance therefore seed coat color could be one of traits used to predict resistance of field pea to *Colosobruchus chinensis.* L. The results were in agreement with [10]. This shows there is a possibility to reduce insect pest losses through using promising genotypes with some insect pest management practice.

The genotypes thru grey and grey/green seed color were showed less insect infestation with high germination percentage, whereas white, creamy, dun, light green, mottled and brown seed genotypes were showed high insect infestation with low germination percentage (table 4). The genotypes with larger seed size are highly infested by this insect than the genotypes per smaller seed size. This might be resulted from the natural behavior of this insect during their life time that searching of wide space for eggs laid that is the one case why the larger seed size genotypes per high number of adult emergency and high percentage of seed weight loss. Related works also reported by [36, 29] that increased adult emergence produces a corresponding increase in percent weight loss in grains until there is no more food for larva development in the grains

This result suggest that the relative resistance to adzuki bean beetle in the studied field pea genotypes might be due to the presence of antixenosis and antibiosis resistance mechanism on the seeds, which might have acted as a deterrent to oviposition, adult developmental and weight loss in those genotypes. In line with this, a legume crops with small-sized seeds wrinkled, hardness, rough, almost spiny seed coat and different chemical constituents were showed more resistance to bruchids [37, 3, 21, and 33]. Based on the current investigation there is no complete resistance of field pea genotypes to adzuki bean beetles infestation But there is some field pea genotypes (*Pisum var. abyssinicum*) which performed a moderately resistance to this insect, that might be due to morphological (their special seed character like small seed size, high proportion of seed coat and wrinkled seed shape than those improved and introduced *P. sativum* genotype) and also due to biochemical defenses mechanisms (table 4). This could be the genetic gap between moderately resistant and susceptible genotypes was evident suggesting that the variability was an important trait for classification of genotypes.
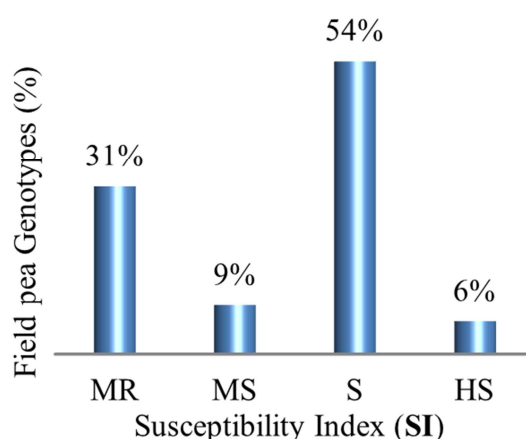

Figure 1. The overall performance of considered field pea genotypes to adzuki bean beetles (Collosobruchus chinensis L.).

*** MR: Moderately resistance, MS: Moderately susceptible, S: Susceptible and HS: Highly susceptible

Table 4. *The mean performance of the considered field pea genotypes to adzuki bean beetle (Collosobruchus chinensis L.).*

Genotype Number	Testa color	TSW	Initial weight (mg)	Final weight (mg)	Weight loss (%)	Number of Egg	Number of adult	MDP (days)	G (%)	DSI	Status
1	grey/green	68	13.6	13.1	10.0	89	36	21	82	5.07	MS
2	grey	74	14.8	13.6	11.1	78	40	27	78	4.77	MR
3	grey/red	72	14.4	13.3	13.1	80	47	23	74	6.42	MS
4	grey/red	65	14.2	13.5	12.8	93	46	29	74	6.80	MS
5	grey/green	64	12.2	11.5	8.9	76	32	24	90	4.06	MR
6	grey	71	14	10.7	24.8	105	89	23	60	4.94	MR
7	grey	58	15.6	12.9	13.7	97	49	25	73	5.40	MS
8	grey	65	12.4	10.4	13.1	79	47	26	72	5.30	MS
9	grey	75	13.2	7.3	16.7	97	60	24	66	4.47	MR
10	grey	64	13.4	9.5	24.0	120	86	30	58	6.01	MS
11	white	151	30.2	23.5	36.8	170	132	28	40	7.57	S
12	white	191	38.2	29	36.8	168	132	25	37	11	HS
13	white	184	36.8	28.5	59.1	228	212	27	29	8.61	S
14	Creamy	178	35.6	31.8	37.9	212	136	24	39	10.8	HS
15	Dun	168	33.6	25.7	43.5	197	156	28	41	7.83	S
16	Dun	170	34	22.7	37.1	175	133	28	47	7.58	S
17	Mottled	183	36.6	26.8	36.8	200	132	28	42	7.57	S
18	Dun	220	44	30.1	59.6	234	214	27	27	8.63	S
19	Light Green	207	41.4	24.7	55.7	229	200	32	28	7.19	MS
20	Creamy	216	43.2	33.38	42.6	194	153	26	38	8.40	S
21	Creamy	179	35.8	25.7	41.8	186	150	26	40	8.36	S
22	Creamy	169	33.8	25.9	39.0	164	140	25	44	8.58	S
23	Brown	174	34.8	27.5	37.9	196	136	30	49	7.11	MS
24	Creamy	181	36.2	27.7	27.9	150	100	23	51	10.9	HS
25	Creamy	187	37.4	26.4	41.2	196	148	30	48	7.23	MS
26	brown	213	42.6	29.4	58.8	229	211	31	22	7.49	MS

*** TSW; thousand seed weight, MDP; mean developmental period, G (%); Germination percentage and DSI; Dobie susceptibility index

Figure 1 grants SI ranges of the studied 26 field pea genotypes. Around 31% of the genotypes were moderately resistant (MR), 9% of the genotypes showed moderate susceptible, 54% were susceptible and 6% were highly susceptible indicating genetic variability in the studied genotypes. Predominant susceptibility index was four collections genotypes; fpcoll-30/07 had the lowest SI (4.06), followed by fpcoll-42/07 (4.47), fpcoll-2/07 (4.77) and fpcoll-31/07 (4.94) whereas Burkitu, Tegegnech and PDFPT P-313 MILKY had the highest SI (>10) (Table 4).

Magnitude of infestation was also varied that may indicated existence of genetic diversity among tested genotypes and thus the genotypes collection could provide parent materials for genetic studies. Mechanisms of resistance were beyond the scope of this study, but with the present findings, it can be speculated that the genotypes possess different intrinsic and extrinsic factors of different levels, which conferred different resistance levels either through antibiosis, antixenosis or both. Genotype fpcoll-30/07 and fpcoll-1/07 had the least mean of adult emergence (32 and 36), while the highest mean was observed on Bilalo, Adi and Ek-08021-5 (214, 212 and 211) (Table 4). The mean adult insect emergence for the moderately resistant genotypes was 54.5; the moderately susceptible genotypes 100.6, susceptible genotype 158; while the highly susceptible genotypes had a mean of 184 adults. Of the 26 studied genotypes, 53.8% had the number

of adult emergence below the experimental mean value of 124.3. Related works were also reported on different legumes crops by [30, 27, 2].

Results on median development periods (MDP) of the 26 studied genotypes are presented on table 4. Twenty-six percent of the genotypes had MDP of < 24 days, 65.4% had MDP of < 30 days, and 7.7% had MDP of < 35 days. No genotype had MDP below 21 days; while 50% of the genotypes had MDP above the mean experimental mean (26.5 days). The predominant MDP was 28 days. Genotype 'Letu' had the longest MDP of 32 days; followed by 'Ek-08021-5 MILKY' with 31 days; while 'fpcoll-01/07' had the least MDP of 21 days (Table 4). This indicates variability in the genotypes, with genotypes having the longest development periods (Table 4) indicating that such genotypes probably were either hard-textured or difficult to ingest or digest for the larvae; partially toxic and/or nutritionally inadequate to support optimal development rates of the pest. In line with this [35, 12, 17] also reported similar finding on soya bean crop.

11. Field Pea Genotypes for Physiochemical Analysis

The mean performance of the considered field pea genotypes for some nutrients analysis were showed a

significant difference (p<0.01, p<0.05) in table 3. Numerically the values of each genotype for the considered nutrient composition were also varying in a table below (table 4). Accordingly genotypes; fpcoll-1/07, fpcoll-2/07, fpcoll-28/07, fpcoll-29/07, fpcoll-30/07, fpcoll-31/07, fpcoll-40/07, fpcoll-41/07, fpcoll-42/07/ had high values (ppm) for;

ca, k, mg, and zn, whereas all improved, introduced crossed line of considered field peal genotypes had low values (ppm) for the above nutrients. In line with this there is positive association among nutrients per some exceptions (Ca with Cu, Se, Zn) and K with Cu) i.e. as the values of one nutrient increase the other were declined.

Table 5. The mean performance of nutrient analysis for different field pea genotypes.

Genotypes Number	Ash (%)	Moisture (%)	Total Nitrogen (%)	Protein (%)	Ca (ppm)	Fe (ppm)	K (ppm)	Mg (ppm)	P (ppm)	Zn (ppm)
1	4.43	11.7	2.51	23.4	983	64	14316	1707	5736	12.4
2	3.56	10.1	2.56	17.1	1004	53	13222	1686	5538	13.8
3	4.13	11.1	2.58	17.2	609	50	12329	1486	5031	13.4
4	4.62	98.1	2.63	17.6	785	48	13373	1777	5669	16.3
5	3.57	9.62	2.41	16.1	983	50	13560	1807	5831	17.3
6	3.82	10.2	2.67	17.8	804	51	12100	1649	5086	14.9
7	3.73	11.2	2.76	18.4	719	37	14359	1495	5086	17.1
8	4.21	13.2	2.87	19.2	1055	63	16432	1453	4369	12.2
9	4.16	11	2.52	16.8	963	39	15296	1632	5885	20.6
10	3.76	11.4	2.54	17.0	912	47	14533	1655	5237	17.9
11	3.85	9.81	2.7	16.9	446	39	11962	1240	4318	8.7
12	4.02	9.99	2.77	17.3	508	43	11980	1173	3873	8.1
13	3.91	11.7	2.73	17.1	458	49	11262	1295	3762	9.2
14	4.22	11.2	2.61	16.3	509	48	12309	1284	3762	9
15	3.66	12.1	2.67	16.7	451	46	13004	1195	4228	8.6
16	3.93	13.1	2.74	17.1	520	41	12595	998	3847	10.5
17	4.11	9.92	2.66	16.6	497	36	12129	1197	4228	8.6
18	4.12	9.93	2.71	16.9	550	50	12029	1175	4018	8.8
19	4.44	10.3	2.59	16.2	495	41	13853	1221	3518	8.3
20	3.99	11.6	2.58	16.2	679	45	12318	1187	4969	17.7
21	4.1	11.6	2.51	15.7	720	48	12429	1173	5122	16.7
22	3.88	11.8	2.57	16.1	698	48	11889	986	5429	16.9
23	3.87	12.1	2.61	16.3	615	45	12215	1088	5236	14.9
24	4.12	11.5	2.62	16.4	733	62	12271	1327	5947	21
25	4.13	11.1	2.66	16.7	708	53	12448	1175	5039	18.8
26	3.96	10.9	2.57	16.1	722	49	12327	1429	4928	14.9

*** Ppm: parts per million

12. Conclusion

Mainly field pea is serving as a stable food crop in Ethiopia. However there are many determinants that hinder the potential of the crop (low productivity), even if Ethiopia is one of the centers of diversity for this crop. In addition to this the actual nutrient composition of the considered genotypes were also not well known. Mainly *collosobruchus chinensis* L. were the major one that why this study were focuses on evaluation of different field pea genotypes seeds to adzuki bean beetles resistance and mineral content of the considered genotypes. Results were revealed that there is no complete resistance for this pest but there are some promising genotypes to this pest with good nutrient composition that could be used with other pest management practices in future breeding system.

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