

GROWTH, FRESH POD YIELD AND GENOTYPE X ENVIRONMENT INTERACTION OF NINE GARDEN PEA (*Pisum sativum* L.) GENOTYPES GROWN IN THREE LOCATIONS OF BENGUET

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RATIONALE



GARDEN PEA

- One of the most important vegetable cash crops in the country
- It is a versatile crop as source of protein in the diet having essential amino acids
- It is a cool season annual crop
- Grows best in cold and dry climate
- Longer cold helps in increasing the yield of garden pea (DAFF, 2011)
- Benguet is a major producing area in the country supplying around 80% of the total needs of the Philippines

- Benguet farmers are highly dependent on traditional varieties which are inferior in quality
- They keep on demanding for new improved varieties
- The BSU- IPB breeding team had developed and selected potential genotypes for commercialization
- These genotypes are needed to be evaluated in different production sites in Benguet
- To identify the most adapted and high yielding potential varieties for commercialization
- The selection of best adapted variety in specific location and observation of its performance across different sites can be achieved through systematic evaluation in a multi- locational trial

- The interaction of G x E makes it difficult to identify the best genotype
 - In the absence of G x E, superior genotype in one environment may be regarded as superior genotype in all
 - Whereas the presence of G x E interaction confirms particular genotype being superior in particular environment (Bondari, 2003)
- Information on the G x E interaction leads to successful evaluation of stable genotypes (Tariku *et al.*, 2013)
- A stable genotype is that one that performs consistently in all test locations
- Understanding the causes of G x E interaction can be used to
 - establish breeding objectives
 - identify ideal test conditions and
 - formulate recommendation for areas of optimum cultivar adaptation (Yan, 2001)

OBJECTIVES



The study was conducted to:

1. Determine the growth and fresh pod yield of nine garden pea genotypes grown in three locations in Benguet,
2. Determine the best location for growing garden pea genotype,
3. Determine the genotype x environment interaction effect on the growth and yield of garden pea genotypes in the three locations in Benguet, and
4. Determine the profitability of growing garden pea genotypes in the three locations of Benguet.

TIME AND PLACE OF THE STUDY



- The study was conducted from January to May 2016
 - ❖ Betag, La Trinidad, Benguet (1,316masl)



❖ Ambassador, Tublay, Benguet (1,445 masl)



❖ Caliking, Atok, Benguet (1,668masl)



METHODOLOGY



- Area: 116 m²/location
- Plot: 31 plots with 0.75 m x 5 m size
- Design: Randomized Complete Block Design (RCBD) with three replications in each location

TREATMENTS

Genotype (G):			Environment (E):		
<u>Code</u>	<u>Genotype</u>	<u>Source</u>	<u>Code</u>	<u>Location</u>	<u>Elevation</u>
G ₁	Betag	BSU- IPB- HCRS	E ₁	Betag, La Trinidad	1,316 masl
G ₂	CGP 11	BSU- IPB- HCRS	E ₂	Ambassador, Tublay	1,445 masl
G ₃	CGP 13	BSU- IPB- HCRS	E ₃	Caliking, Atok	1,658 masl
G ₄	CGP 34	BSU- IPB- HCRS			
G ₅	CGP 59	BSU- IPB- HCRS			
G ₆	CGP 110	BSU- IPB- HCRS			
G ₇	CGP 154	BSU- IPB- HCRS			
G ₈	Chinese Light Green (CLG)	BSU- IPB- HCRS			
G ₉	Taichung	BSU- IPB- HCRS			

- **Data** on growth and development were gathered per treatment per replication
- **Data Analysis**
 - ANOVA for RCBD with three replications
 - DMRT at 5% for test of significant differences among treatment means per environment
 - Pooled/ Combined ANOVA was used to determine G x E interaction effects
 - AMMI analysis was used to determine the stable and adapted genotypes per environment and across environments

RESULTS AND DISCUSSION

Table 1.	The average daily temperature, relative humidity and rainfall amount from January to May 2016 at three locations in Benguet			
MONTH	TEMPERATURE (°C)		RELATIVE HUMIDITY (%)	RAINFALL AMOUNT (mm)
	MIN.	MAX.		
<u>LA TRINIDAD</u> * (1,316 masl)				
January	15.00	23.50	89.50	0.20
February	15.35	22.85	81.50	1.84
March	16.10	24.95	81.00	0.50
April	15.80	25.50	84.00	1.60
May	18.98	25.37	90.19	4.20
<u>TUBLAY</u> (1,445 masl)				
January	15.00	19.00	88.00	0.00
February	12.25	21.00	83.00	0.40
March	14.50	22.33	81.00	0.00
April	15.50	23.33	79.00	0.59
May	18.00	25.20	83.00	2.00
<u>ATOK</u> (1,658 masl)				
January	13.00	18.00	88.00	0.00
February	11.67	18.84	82.00	0.50
March	14.19	23.00	80.00	0.00
April	15.75	24.00	78.00	0.00
May	17.75	24.67	86.00	2.19
*Source: BSU, PAGASA, Agriculture Meteorology Research Station				

Table 2.	Soil chemical properties before planting and after harvesting in three locations in Benguet				
ENVIRONMENT	pH	ORGANIC MATTER (%)	NITROGEN (%)	PHOSPHORUS (ppm)	POTASSIUM (ppm)
<u>BEFORE PLANTING</u>					
La Trinidad	5.18	10.12	0.51	155.00	37.00
Tublay	6.09	3.00	0.15	84.00	466.00
Atok	5.32	3.50	0.18	8.00	290.00
<u>AFTER HARVESTING</u>					
La Trinidad	6.02	4.00	0.20	120.00	672.00
Tublay	5.51	3.00	0.15	110.00	516.00
Atok	5.15	2.50	0.13	57.00	416.00
Analyzed by: Soils Laboratory, Baguio City					

Maturity Indices

- Differed significantly among genotypes tested in different environments
- Betag was the first to be harvested among the genotypes (48 DAP), one to six days earlier than the other genotypes
- Garden pea grown in Atok were harvested earliest at 50 DAP, 1 to 2 days earlier than those grown in La Trinidad and Tublay

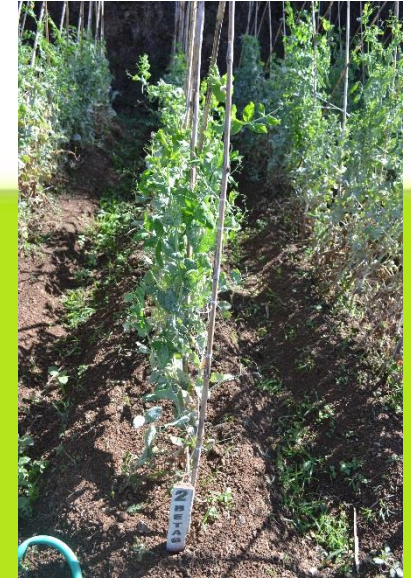


Figure 1. Interaction effect of genotype and environment on the number of days from sowing to emergence

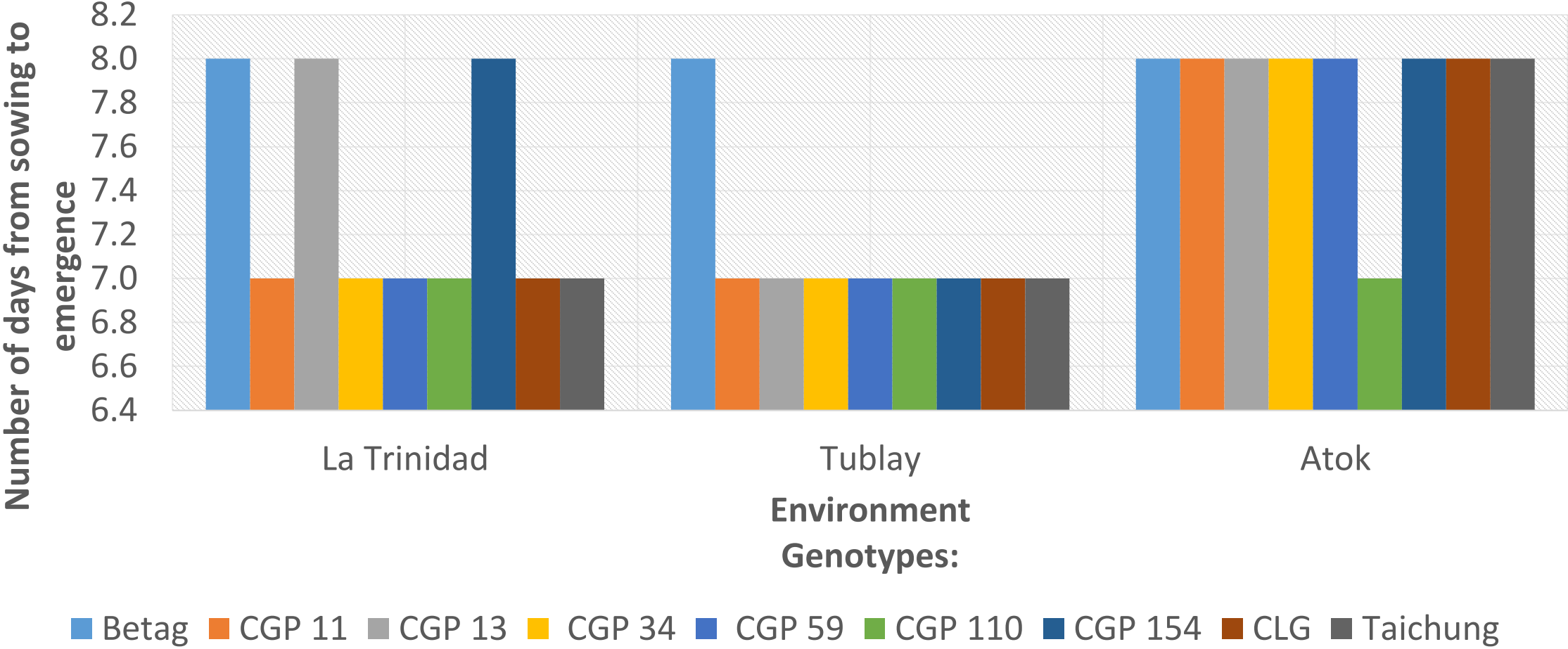


Figure 2. Interaction effect of genotype and environment on the number of days from emergence to first flowering

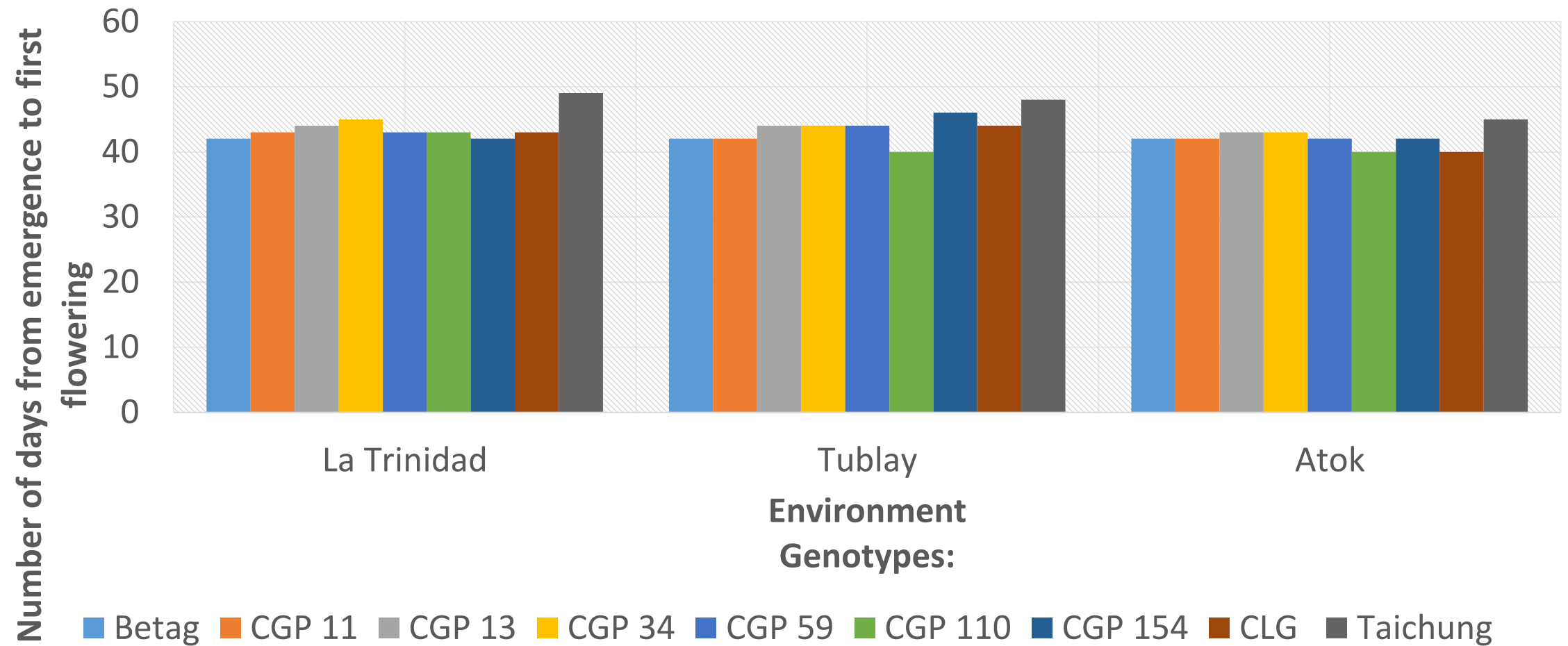


Figure 3. Interaction effect of genotype and environment on the number of days from emergence to last flowering

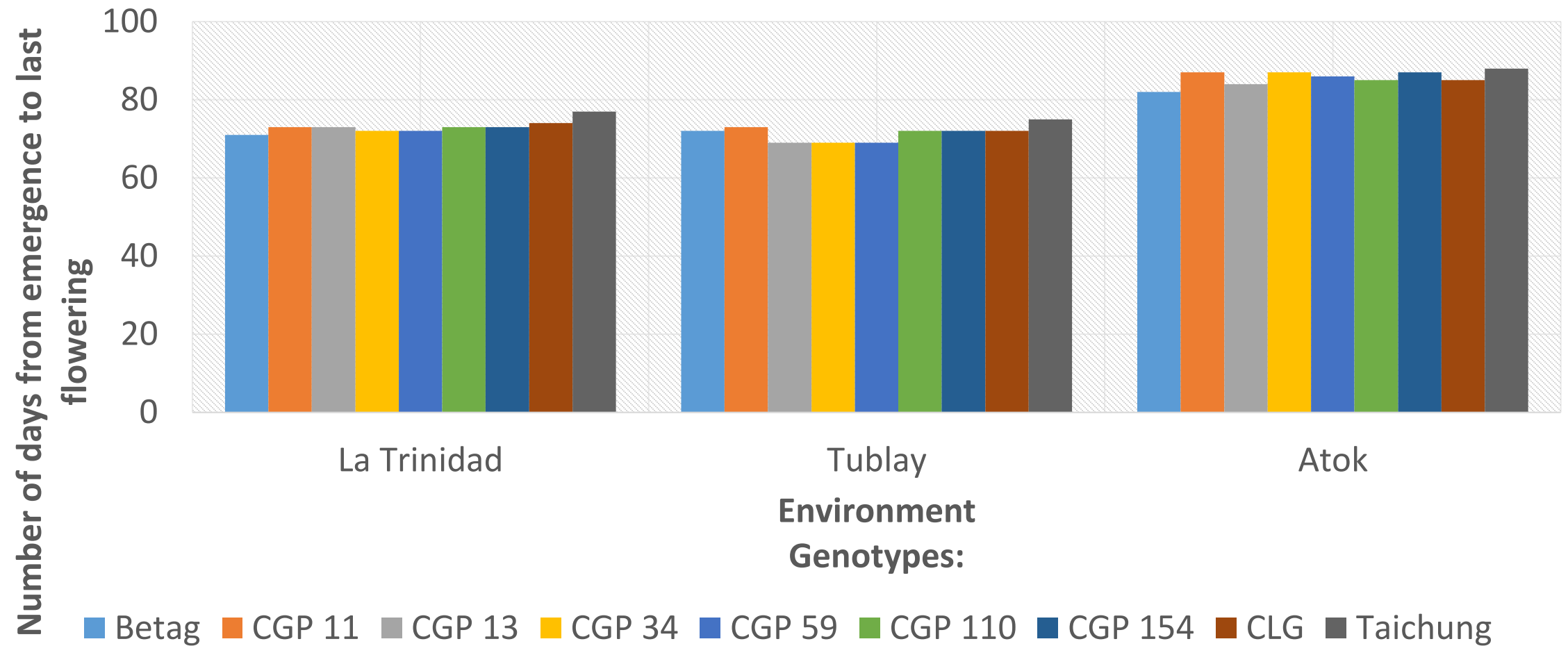


Figure 4. Interaction effect of genotype and environment on the number of days from flowering to pod setting

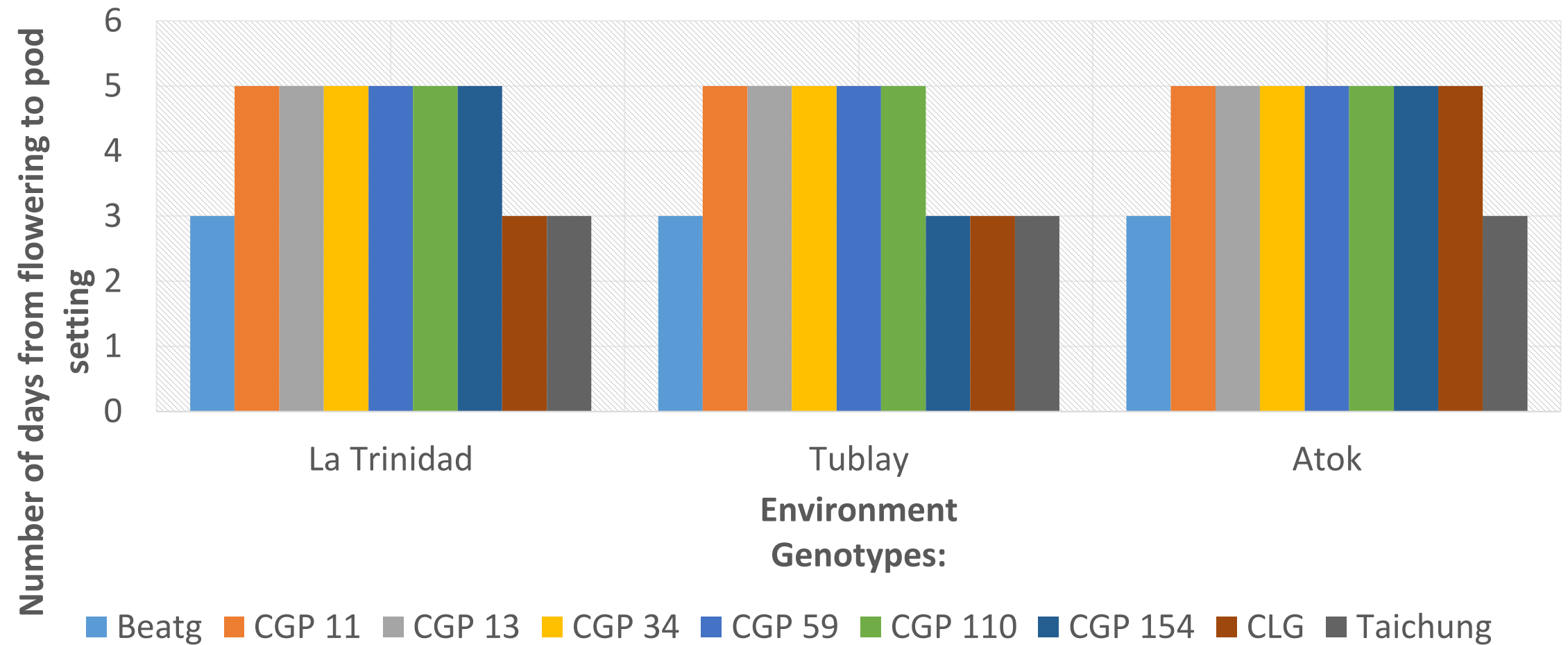


Figure 5. Interaction effect genotype and environment on the number of days from pod setting to pod maturity

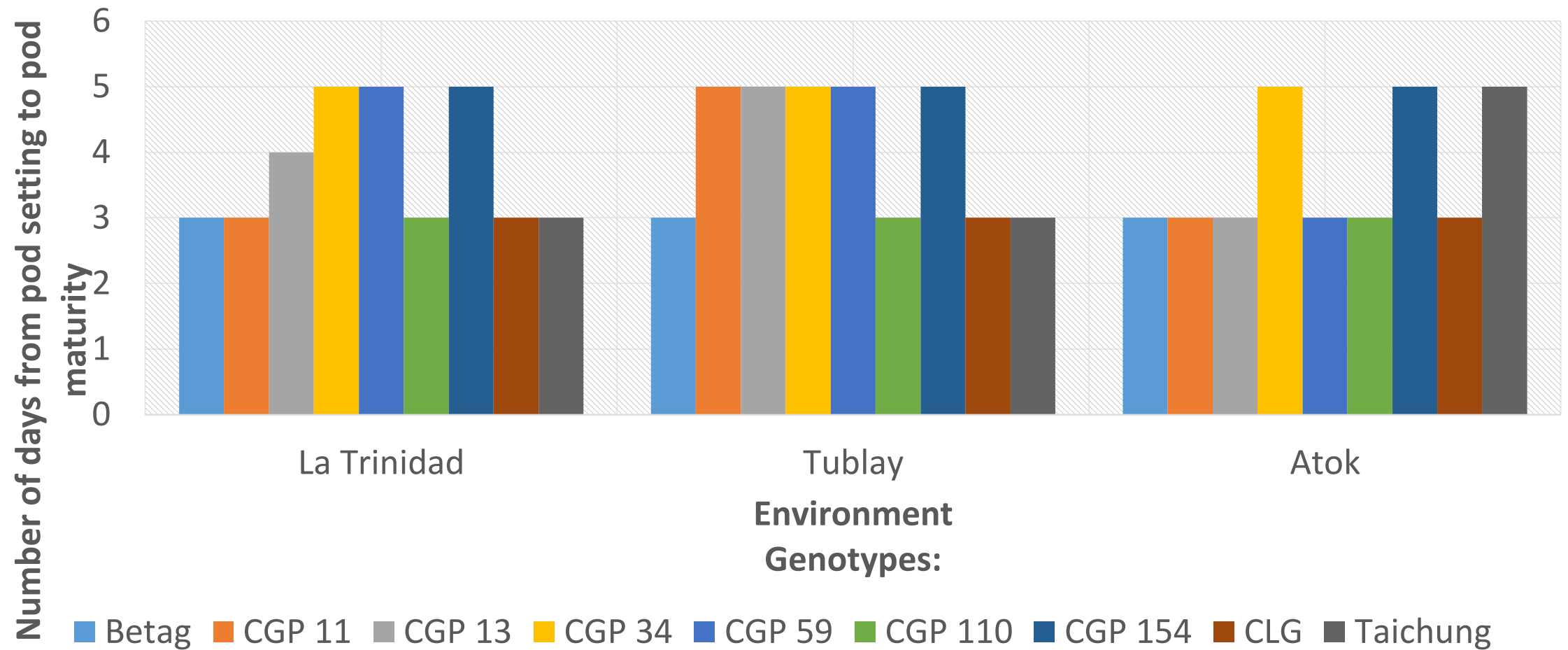


Figure 6. Interaction effect of genotype and environment on the number of days from emergence to harvesting of fresh pods

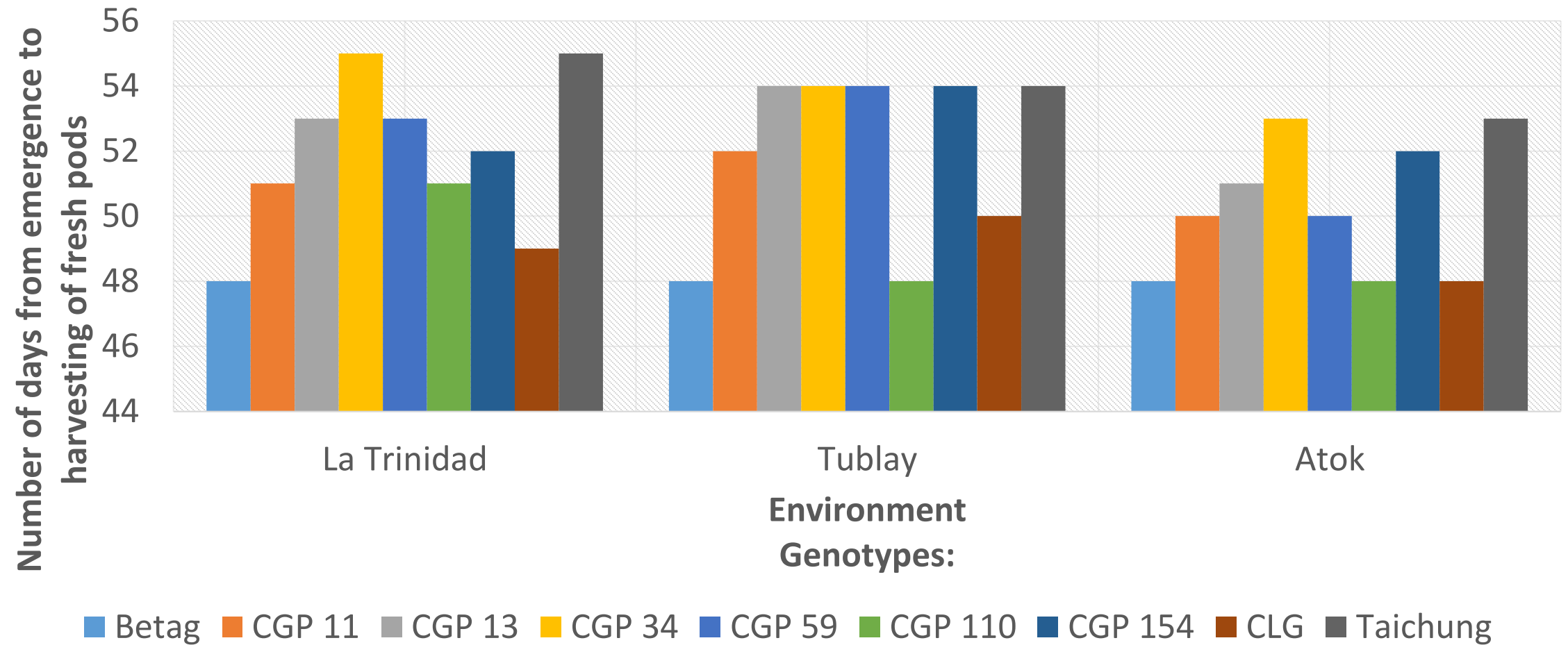


Figure 7. Interaction effect of genotype and environment on the number of pods per plot

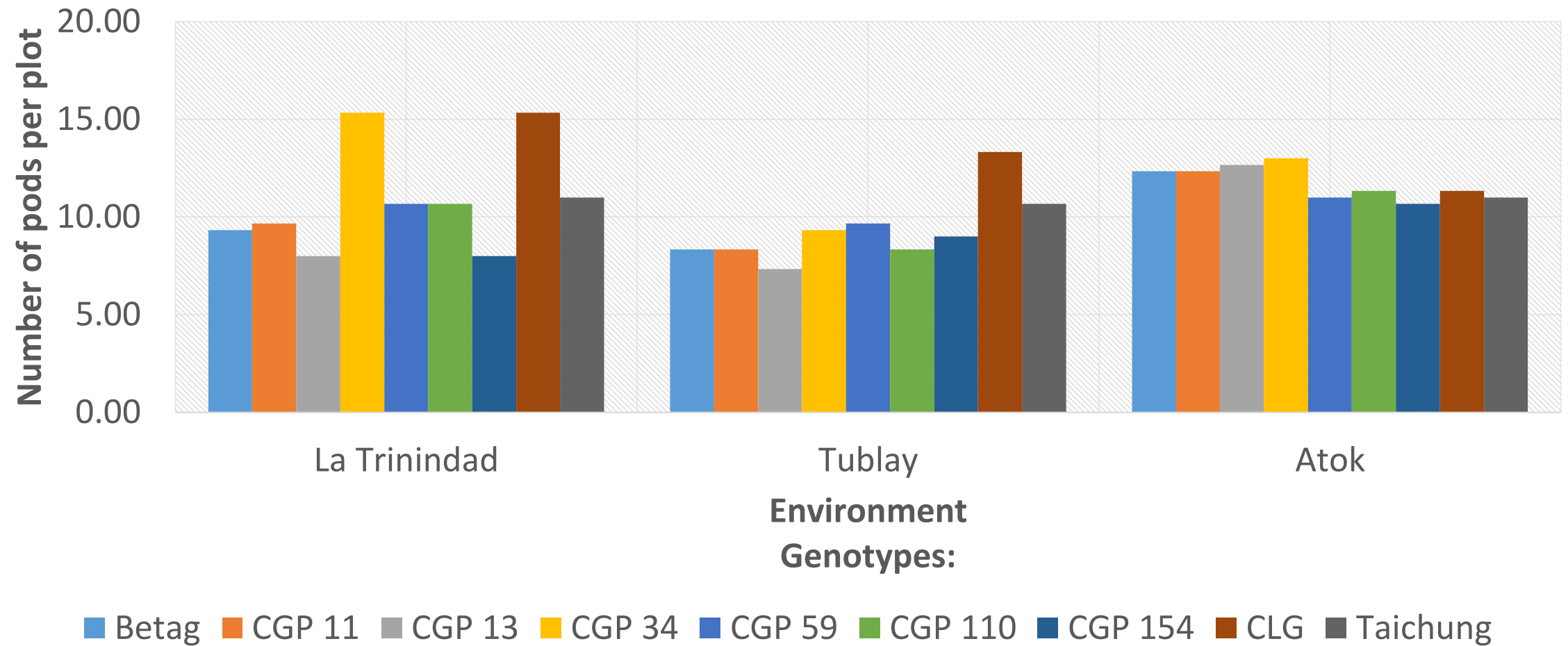


Figure 8. Interaction effect of genotype and environment on pod length (cm)

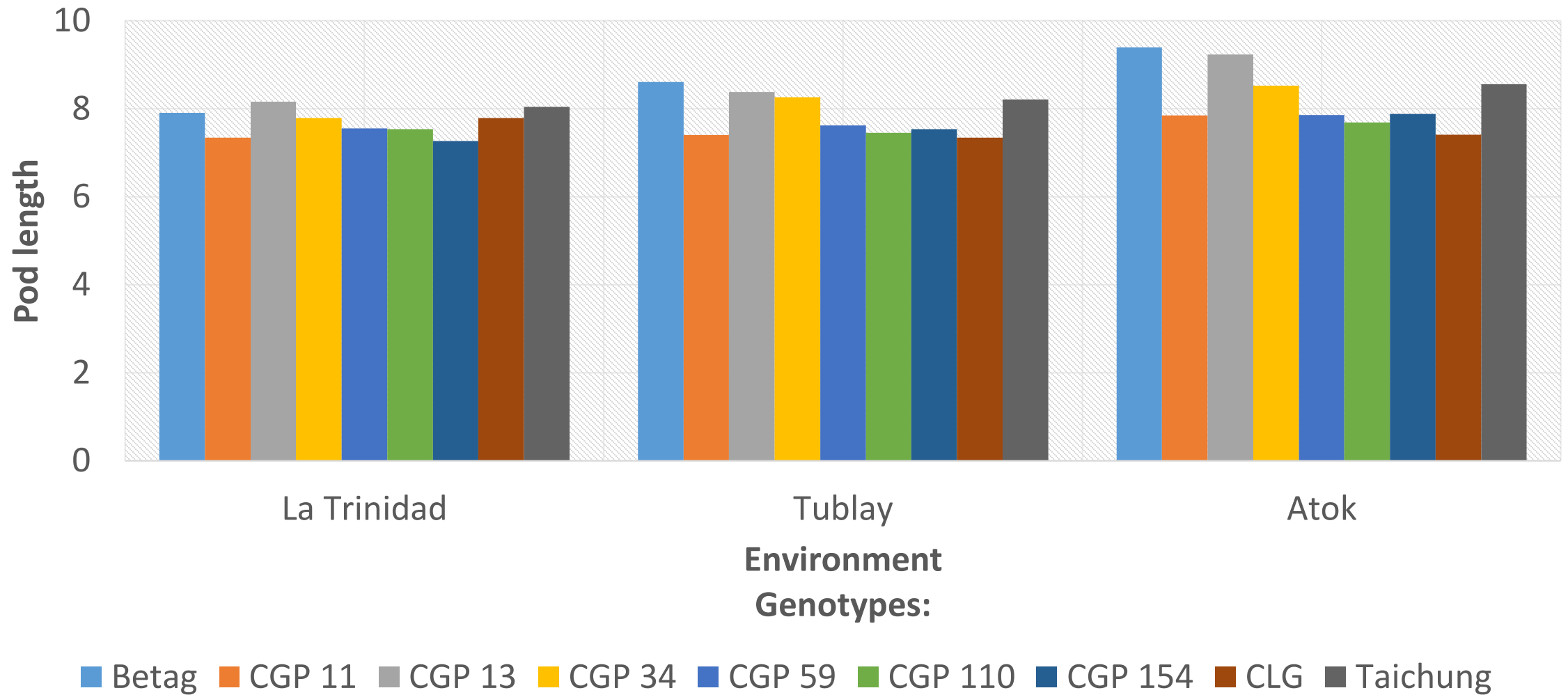


Figure 12. Interaction effect of genotype and environment on pod width (cm)

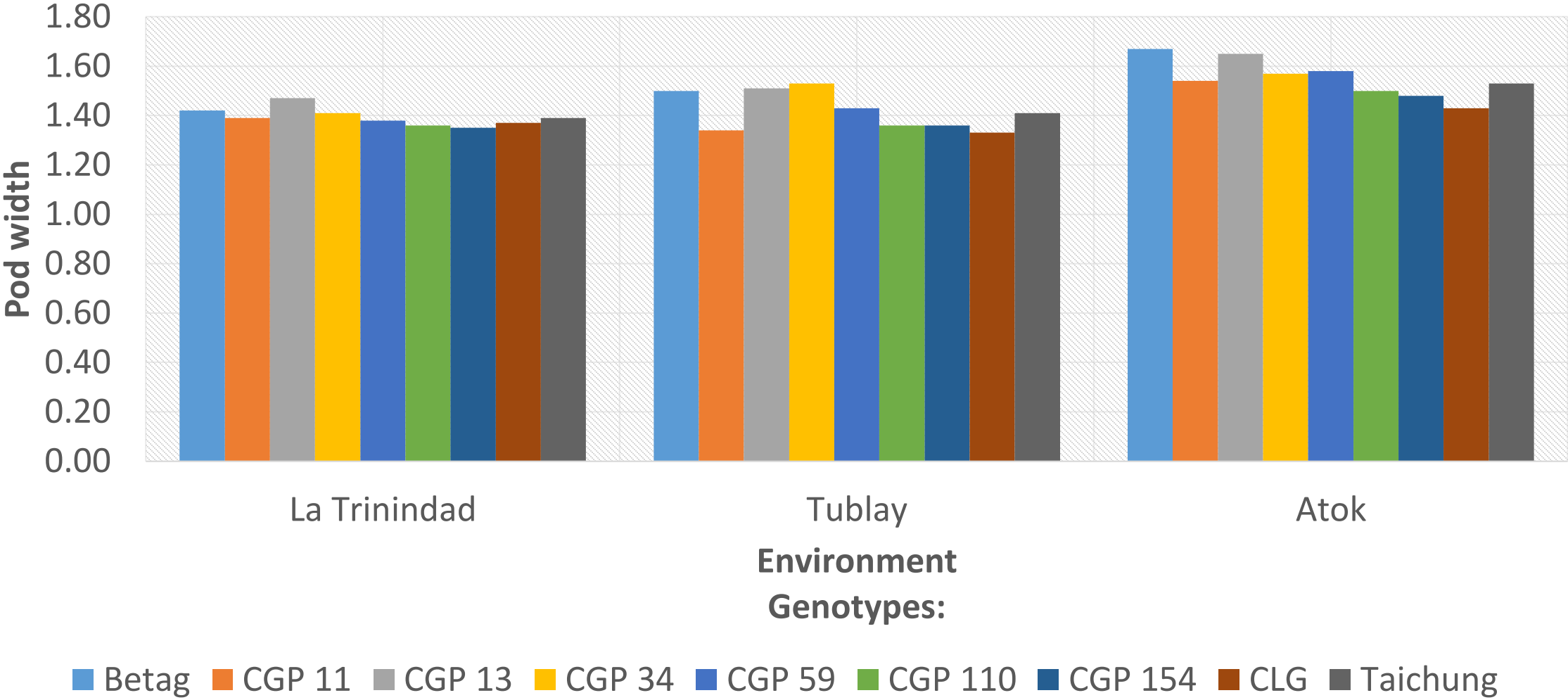


Table 8.	Number of marketable, non- marketable and total fresh pod per plot (3.75 m ²) of the nine garden pea genotypes grown in three environments in Benguet											
GENO- TYPE	NUMBER OF PODS PER PLOT (3.75 m ²)											
	MARKETABLE				NON- MARKETABLE				TOTAL			
	LTB	TB	AB	MEAN	LTB	TB	AB	MEAN	LTB	TB	AB	MEAN
Betag	476.00 ^{cde}	420.67	752.33	549.67 ^{cd}	82.33 ^d	59.67	63.00	68.33 ^{cd}	558.33 ^{def}	480.33	815.33	618.00 ^{de}
CGP 11	655.00 ^{bcd}	503.33	847.33	668.55 ^{ab}	100.67 ^{cd}	59.67	66.67	75.67 ^{bcd}	755.67 ^{cde}	563.00	914.00	744.22 ^{bc}
CGP 13	428.00 ^{de}	373.00	828.33	543.11 ^{dc}	80.00 ^d	53.00	58.67	63.89 ^d	508.00 ^{ef}	426.00	887.00	607.00 ^e
CGP 34	920.33 ^a	591.33	824.67	778.78 ^a	156.67 ^a	62.67	68.33	95.89 ^a	1077.00 ^a	654.00	893.00	874.67 ^a
CGP 59	707.33 ^{abc}	507.67	740.00	651.67 ^{bc}	116.33 ^{bc}	60.33	64.33	80.33 ^{bc}	823.67 ^{bc}	568.00	804.33	732.00 ^{bcd}
CGP 110	692.33 ^{abc}	561.67	779.00	677.67 ^{ab}	93.33 ^{cd}	61.33	68.33	74.33 ^{bcd}	785.67 ^{bcd}	623.00	847.33	752.00 ^{bc}
CGP 154	404.33 ^e	475.00	655.67	511.67 ^d	73.33 ^d	64.67	61.67	66.56 ^d	477.67 ^f	539.67	717.33	578.22 ^e
CLG	886.33 ^{ab}	674.00	685.33	748.55 ^{ab}	133.67 ^{ab}	61.67	59.33	84.89 ^{ab}	1020.00 ^{ab}	735.67	744.67	833.45 ^{ab}
Taichung	645.67 ^{bcde}	609.00	641.00	631.89 ^{bc}	85.00 ^{cd}	55.67	60.00	66.89 ^d	730.67 ^{cdef}	664.67	701.00	698.78 ^{cde}
MEAN	646.15 ^b	523.96 ^c	750.41 ^a	640.17	102.37 ^a	59.85 ^b	63.37 ^b	75.20	748.52 ^b	583.82 ^c	813.78 ^a	715.37
G x E				**				**				**
CV (%)	20.09	20.71	13.16		17.04	7.50	10.25		18.27	18.86	12.52	

*Means with same letter are not significantly different at 5% DMRT

*Legend: LTB= La Trinidad, Benguet; TB= Tublay, Benguet; AB= Atok, Benguet

Figure 13. Interaction effect of genotype and environment on the number of marketable fresh pods per plot

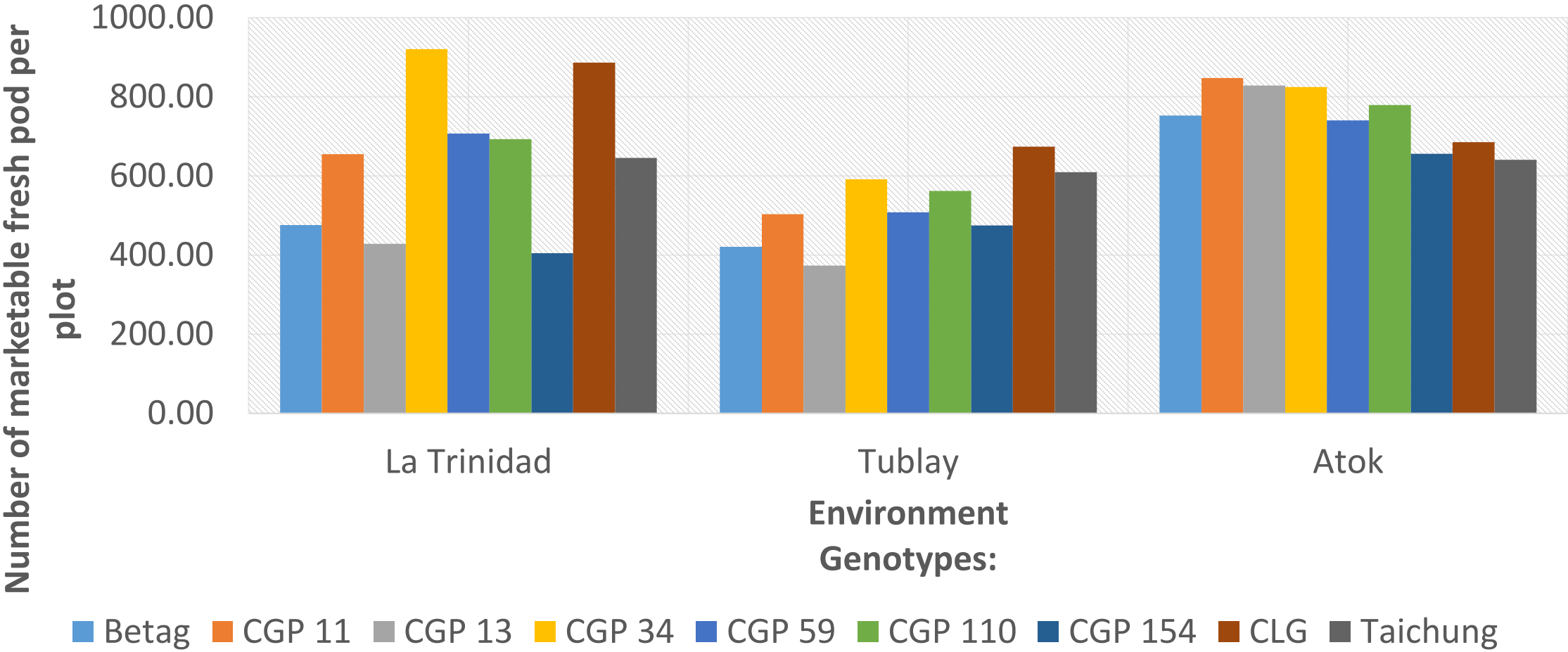


Figure 14. Interaction effect of genotype and environment on the number of non-marketable fresh pods per plot

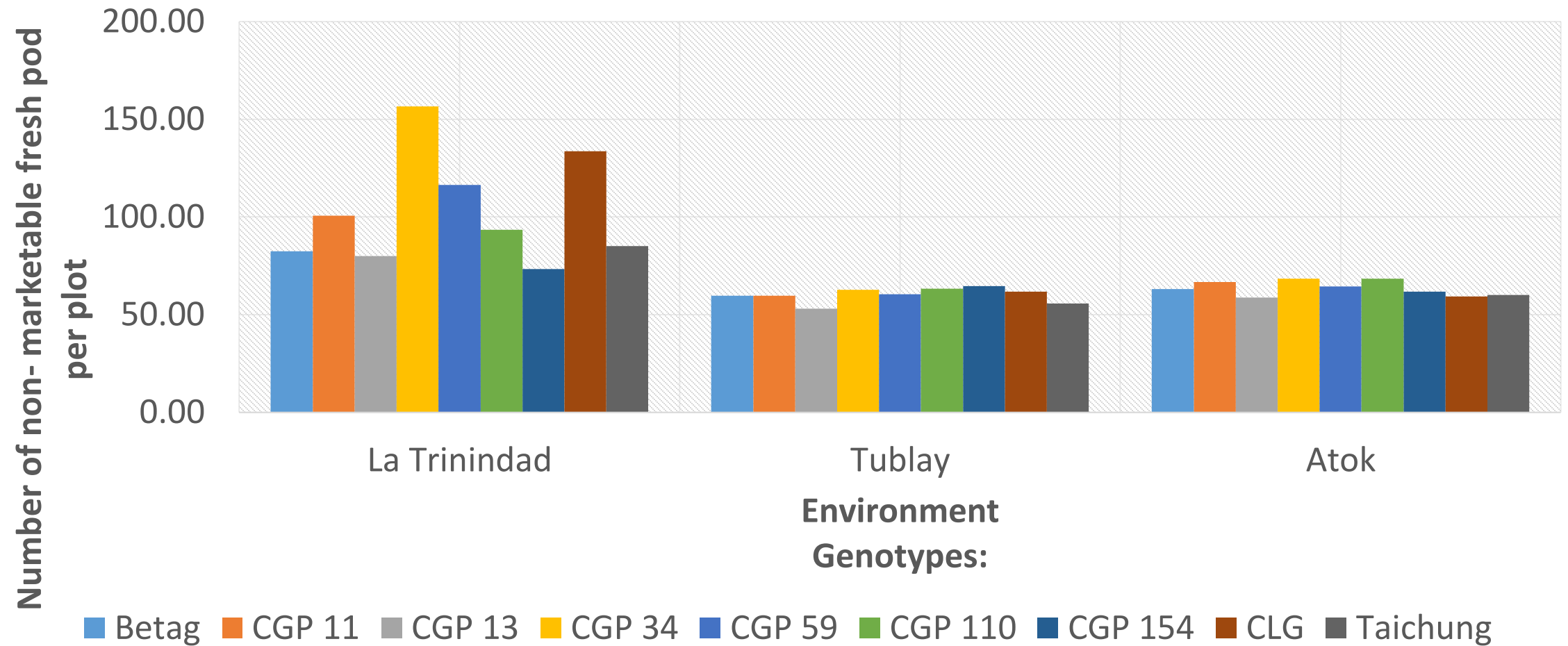


Figure 15. Interaction effect of genotype and environment on the total number of fresh pods per plot

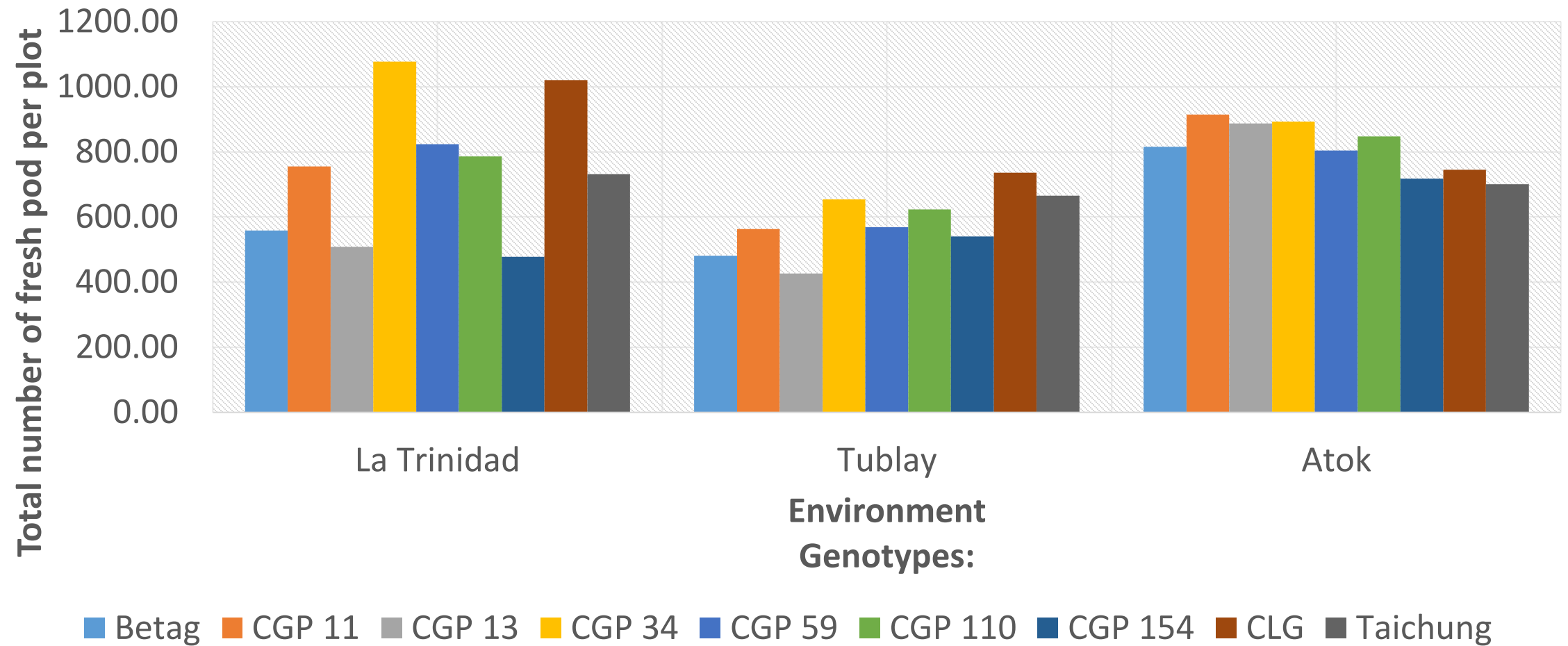


Figure 16. Interaction effect of genotype and environment on the weight of marketable fresh pods per plot

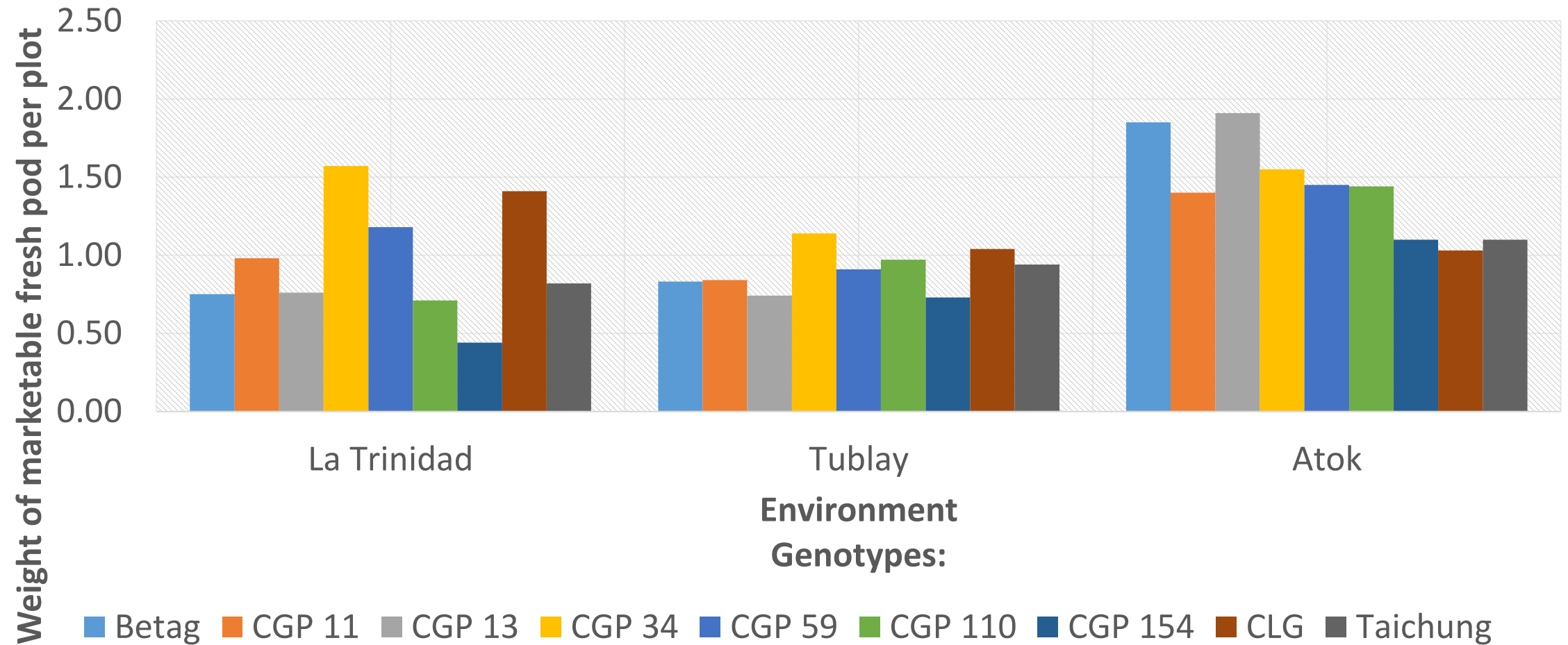


Figure 17. Interaction effect of genotype and environment on weight of non-marketable fresh pods per plot

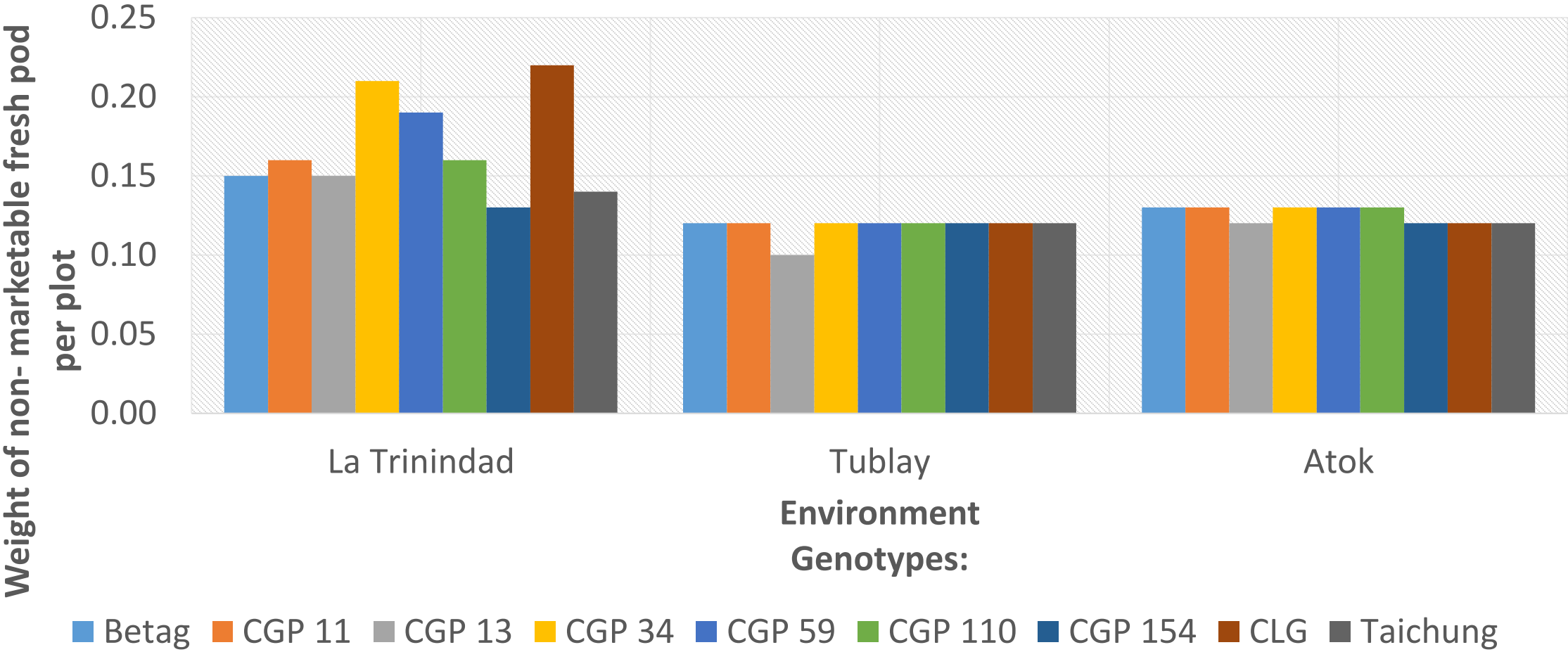
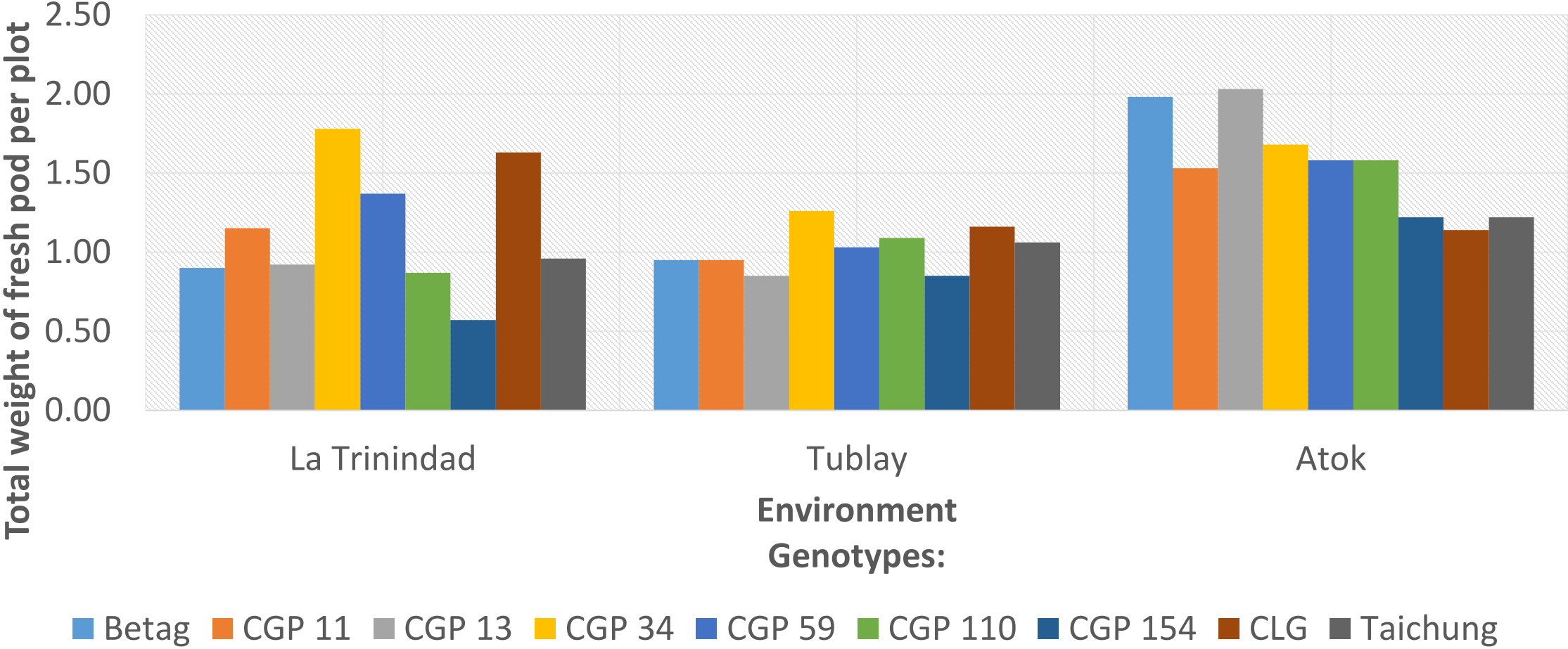
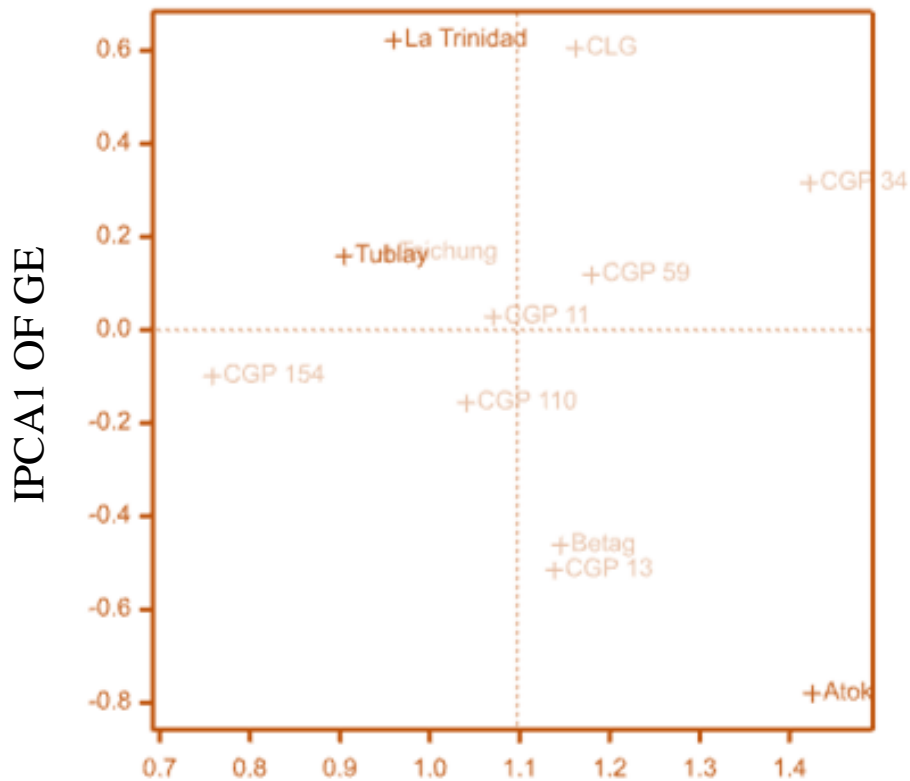


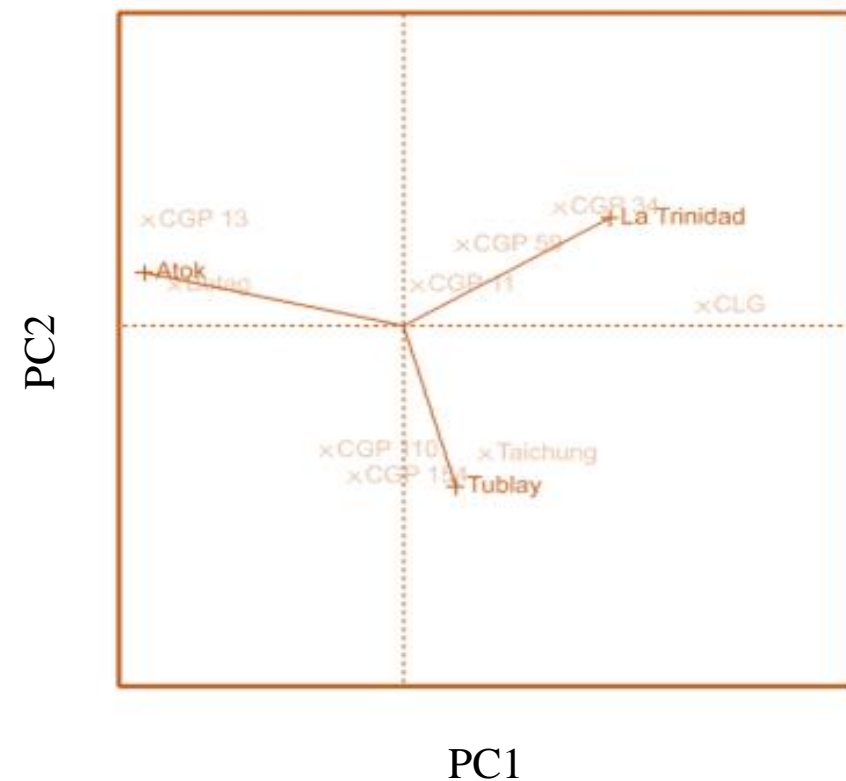
Figure 18. Interaction effect of genotype and environment on the total weight of fresh pods per plot





MEANS
Grand Mean: 1.10 kg

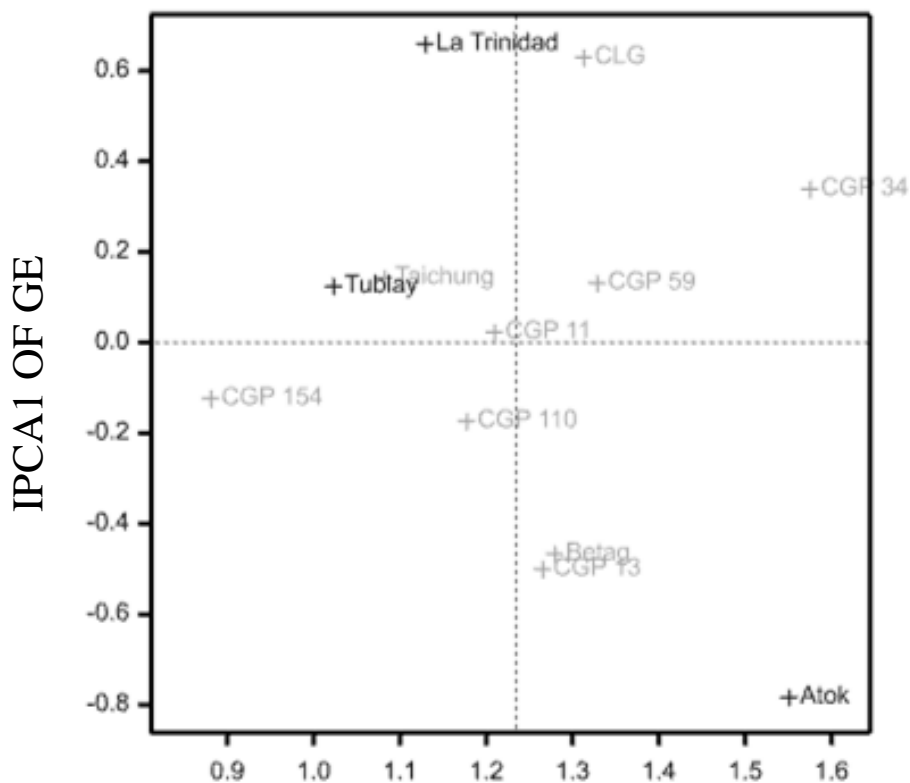
+ Genotype
+ Environment



PC1

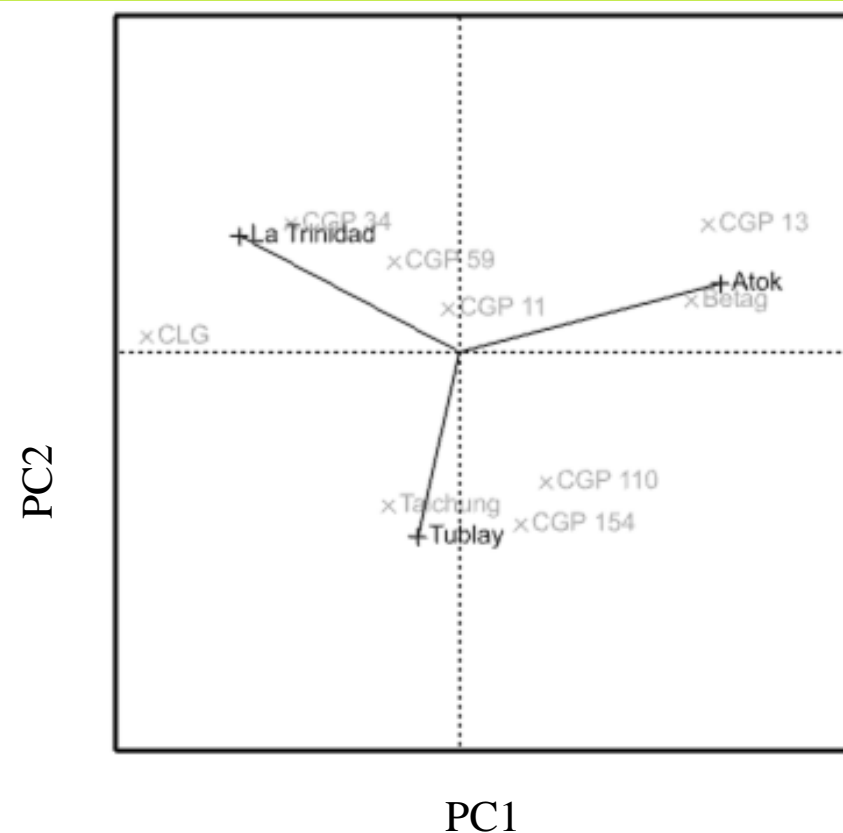
x Genotype
+ Environment
----- Vectors

Figure 19. AMMI 1 and AMMI 2 biplot of nine garden pea genotypes evaluated for weight of marketable fresh pod per plot yield grown in three environments in Benguet



MEANS
Grand Mean: 1.23 kg

+ Genotype
+ Environment



x Genotype
+ Environment
----- Vectors

Figure 20. AMMI 1 and AMMI 2 biplot of nine garden pea genotypes evaluated for total weight of fresh pod yield per plot grown in three environments in Benguet

Table 13.		Reaction on field incidence of pod borer on the nine garden pea genotypes grown in three environments in Benguet								
GENOTYPE		INCIDENCE TO POD BORER AT								
		45 DAP			55 DAP			65 DAP		
		LTB	TB	AB	LTB	TB	AB	LTB	TB	AB
Betag		MR	MR	HR	MR	MR	MR	I	MR	MR
CGP 11		MR	MR	HR	MR	MR	MR	I	MR	MR
CGP 13		MR	HR	HR	MR	HR	MR	I	MR	MR
CGP 34		MR	MR	HR	I	MR	MR	I	MR	MR
CGP 59		MR	MR	HR	I	MR	MR	I	MR	MR
CGP 110		MR	MR	HR	MR	MR	MR	I	MR	MR
CGP 154		MR	HR	HR	MR	MR	MR	I	MR	MR
CLG		MR	MR	HR	I	MR	MR	S	MR	MR
Taichung		MR	MR	HR	MR	MR	MR	I	MR	MR
*Legend: LTB= La Trinidad, Benguet; TB= Tublay, Benguet; AB= Atok, Benguet HR= Highly resistant; MR= Moderately resistant; I= Intermediate; S= Susceptible										

Genotype	Incidence to Pod Borer at								
	45 DAP			55 DAP			65 DAP		
	LTB	TB	AB	LTB	TB	AB	LTB	TB	AB
Betag	MR	MR	HR	MR	MR	MR	I	MR	MR
CGP 11	MR	MR	HR	MR	MR	MR	I	MR	MR
CGP 13	MR	HR	HR	MR	HR	MR	I	MR	MR
CGP 34	MR	MR	HR	I	MR	MR	I	MR	MR
CGP 59	MR	MR	HR	I	MR	MR	I	MR	MR
CGP 110	MR	MR	HR	MR	MR	MR	I	MR	MR
CGP 154	MR	HR	HR	MR	MR	MR	I	MR	MR
CLG	MR	MR	HR	I	MR	MR	S	MR	MR
Taichung	MR	MR	HR	MR	MR	MR	I	MR	MR

*Legend: LTB= La Trinidad, Benguet; TB= Tublay, Benguet; AB= Atok, Benguet
 HR= Highly resistant; MR= Moderately resistant; I= Intermediate; S= Susceptible

CONCLUSION

- The nine genotypes of garden pea differed significantly in growth and yield in the three locations
- Betag was the earliest maturing genotypes across environments
- CGP 34 and CLG are the best genotypes when grown in La Trinidad. They produced the highest marketable and total fresh pod yield per plot.
- In Tublay, CLG had the highest number of flower per plant and pods per plant.
- In Atok, Betag and CGP 13 had the highest fresh pod yield.
- Across environments, CGP 13 and CGP 34 had the highest number of flower and pods per cluster. CGP 34 and CLG had the highest number of marketable and total fresh pods per plot. CGP 34 had the heaviest marketable and total fresh pod yield per plot.

- **Atok** is the **best environment for garden pea production**. Garden pea grown in Atok were moderately resistant to powdery mildew at 75 DAP and less incidence of leaf spot and pod borer. Garden pea grown in Atok produced higher fresh pod yield than grown in La Trinidad and Tublay.
- **Significant interaction effect of genotype and environment** were observed on number of days from sowing to emergence, emergence to first and last flowering, flowering to pod setting, pod setting to pod maturity, emergence to harvesting, number of pods per plant, pod length and width, and number and weight of marketable, non- marketable and total fresh pod per plot.

Result of AMMI Analysis

- CGP 11 was the most stable among the genotypes in terms of weight of marketable and total fresh pod yield per plot
- Betag, CGP 13, CGP 34, CGP 59 and CLG had weight of marketable and total fresh pods per plot greater than the grand mean indicating that they are high yielding garden pea genotypes in all environments
- CGP 11, CGP 34, CGP 59 and CLG had specific adaptability in La Trinidad
- CGP 110, CGP 154 and Taichung in Tublay
- Betag and CGP 13 in Atok.
- Garden pea production is most profitable in Atok

RECOMMENDATION

- In terms of productivity, acceptability and profitability
 - ✓ Betag, CGP 13, CGP 34, CGP 59 and CLG are recommended across environments
 - ✓ In a specific environment



La Trinidad, Benguet



Tublay, Benguet



Atok, Benguet

- But in terms of stability, CGP 11 is recommended



- Atok is best recommended environment for garden pea production because garden pea when grown in Atok is high yielding and more profitable than when grown in La Trinidad and Tublay.





a. La Trinidad

b. Tublay

c. Atok

Hilling- up and trellising of the nine garden pea genotypes grown at three environments (a- c) in Benguet



Other cultural management done



Harvesting of the nine garden pea varieties

Thank you for your kind
attention! 😊