

## Plant Growth, Broad Mite Resistance and Crop Yield of Registered Karen Type Chili Varieties

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**Abstract :** Eight Karen type chili varieties were evaluated with 2 checks by 3 blocks and 5 crops in RCB design in order to register and protect the varieties during June 2011 to November 2012 in Lampang province. Data were recorded for growth of plants, broad mite scored damage, yield and yield components for registration and protection of the variety. The growth of Karen type chili was determined by vegetative growth up to the age of 150 days when it started to stable. The reproductive growth bloomed at 70 to 90 days and started to harvesting date at 100-110 days after transplantation. Months, varieties and interaction between both broad mite rates were highly significant. The Kiriraj 5, Kiriraj 7 and Kiriraj 4 varieties had broad mite rates of 2.0, 2.0 and 2.1, respectively. All characteristics were not significantly different except fresh yield/hectare, fresh yield/plant and fresh fruit weight. The Kiriraj 7 yielded more than commercial variety at 6.2 and 5.1 ton/hectare and 20.9 %. The Kiriraj 1 and 5 had inferior yields of 4.3 and 3.1 ton/hectare, respectively. The Kiriraj 1 to Kiriraj 8 were registered with the Plant Varieties Protection Division, Department of Agriculture on March 28, 2012.

**Keywords :** chili, *Capsicum frutescens* L., plant growth, broad mite *Polyphagotarsonemus latus*

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## 1. Introduction

Chili (*Capsicum* spp.) is considered as one of the most important commercial spice crops and is widely planted in tropic and temperate zones of the world. Dry and fresh chili produced a total of 1,936,956 and 1,897,946 hectare with 3.3 and 29.9 million ton in 2011. Dry and fresh yield produced 3.7 and 25.9 ton/hectare. The increasing produced area of the world was 2.6 % per year during 2007 to 2011. World dry chili production has grown on average 2.6 percent per year during 2007 to 2011 led by a steady increase of global demand. The main dry chili producers in the world are India, China, and Pakistan, which were more than 58 percent of the world dry chili production. Thailand ranked 6<sup>th</sup> place among the global dry chili producers with 64,341 hectare, 139,322 ton and 2.2 ton per hectare which was approximately 4.1 percent of total global production. (FAOSTAT, 2011)

Karen type chili is the local cultivar which has planted in the area between Thailand and Myanmar. These cultivar has a spicy aroma. Farmers grow for dry chili production, but has some of the fresh harvest. Plant growth is perennial and protogynous or intermediate crops which the height and width are 1.0 – 2.0 meters in mature stage. The length of fruit is 4 – 6 centimeter, slender, thin-walled. The color is yellow or yellow - green immature and turning orange to red in mature stage. Farmers plant chili intercrop with corn or rice in the early rainy season (May to June) and harvested after the agronomy crops in the end of rain season during September until the next year. Farmers collect seeds for their own use in the following season. The variation of plant characters express in plant size, fruit shape and color by crossed pollination. (Khanobdee *et al*, 2006) Almost all species of *Capsicum* are self-compatible but, with a degree of exerted stigma that varies with genotype. Actual measurements of outcrossing under field conditions range from 2% to over 90%, depending on locality, environment, and spacing between plants. (Pickersgill, 1997)

Thailand Research Fund (TRF) and Rajamangala University of Technology Lanna (RUTL) cooperate the breeding program of Karen type chili for high yield from 2005 to 2012. The research on the production situation and environments effected on fruit and capsaicin yield in pepper at the northern of Thailand had done during 2005 to 2006. (Khanobdee *et al.*, 2007). The program had collected the local chili varieties from Tak province during 2006 to 2008. The early selected pure lines selected were Phob Phra3 (29), Phob Phra 3 (33), Phob Phra 3 (9) (11/2 self), Phob Phra 3 (25) and Phob Phra 3 (9) (11/1 self) were high fresh and dry yield more than 6.3 and 1.3 ton/hectare. Mae Sod 1 (8), Phob Phra 3 (9) (11/1 self) and Umphange 1 (1) lines had high capsaicinoids between 103,800 to 121,500 SHU. (Khanobdee, 2008 a) The suitable harvesting period for yield and quality of local pepper varieties in Tak province only 119 days from 152 days. The seventh of harvesting period were 89 % and 88 % of the total fresh and dry yield (Khanobdee, 2008 b). The nine selected of S<sub>3</sub> and S<sub>4</sub> lines yielded fresh and dry yield/hectare more than 9.3 and 2.5 ton. The suitable harvesting period was the ninth time which used 111 from 145 days of the eleventh period. The average of the ninth harvesting period of fresh and dry yield/hectare of lines were 87.3 % and 84.1 % of the total yield. (Khanobdee, 2011).

Family Tarsonemidae includes more than 500 world widely distributed mite species. *Polyphagotarsonemus latus* (Banks) is a minute herbivorous mite that attacks numerous plant crops from diverse families including Solanaceae, Cucurbitaceae and Malvaceae causing severe symptoms and yield losses. Its attack is confined mostly to new growths resulting in curling of leaf margins, firmness of infested leaves, necrosis of growing points, aborted buds, malformed fruits and growth inhibition. (Grinberg *et al.*, 2005) The outer cells of the leaf are damaged by the mouthparts of the mites so that they can suck up the sap. The result is that the leaves, apart from becoming distorted, are bronzed, stiff, and rolled under at the margins. Dieback is also a common result from the mites infesting chilies. Broad mites spread by walking short distances; they are spread over long distance by wind as well as on the bodies of insects. Chili in Thailand has propagated and attacked by broad mite especially in rain season. (Manita, 2004)

Registered variety is the system to protect variety in the commercial use. Karen type chili varieties were trialed for the all examination by the official from the Plant Varieties Protection Division, Department of Agriculture. Registered varieties are patented from the violate copyright.

## 2. Materials and Methods

Eight S<sub>3</sub> of elite chili lines from pure line selection with 2 checks were used for 5 field tests during June 2011 to January 2012, July 2011 to May 2012, September 2011 to June 2012, November 2011 to June 2012 and February to November 2012 in the north of Thailand, Lampang province. The experimental design was a randomized complete block design with 3 blocks. Fertilizer was incorporated before planting at a rate of 6 ton of compost and 47-47-47 kg/ha (N-P-K) with an additional 72 kg N/ha applied at 20 days after transplantation and continue every 20 days. Seeds were sown in the plastic box and first transplanted at 1st leaf stage or 10 days after sowing. Chili plants at the 3rd to 5th leaf stage or 30 days were second transplanted in the field. Field plots were arranged by the centers 2.5 m apart and plots 10.0 m long with 14 plants/row in 4 rows. Total plants were 56 plants and were spaced 60 cm between plant and 70 cm between rows (23,810 plants/hectare). Plastic mulch covered, raised – bed system with drip irrigation laid out in all the experiments so that soil moisture did not limiting. Harvesting date and collected data were done 100 to 120 days after transplantation. Harvesting period was 60 to 120 days.

### 2.1 Data collection

2.1.1. Meteorological data during June 2011 to December 2012 at Lampang Agricultural Research and Training Center, Lampang province.

2.1.2. Plant size (height and width) was recorded 20 plants/plot in center rows every month from 30 until 180 days after transplantation.

2.1.3. Plant damage level

All plants were observed for proportion of leaf curled to normal leaf, presence of shoot with leaf falling, or new leaf emerge after shoot damage at every month interval. Plant damage level was categorized into 5 level : 0 = less than 20 %, 1 = 21 to 40 %, 3 = 41 to 60 %, 4 = 61 to 80 % and 5 = more than 81 %.

2.1.4. Yield and yield components All 28 plants in middle two rows were harvested fresh and dry yield, and yield components. Fruit size weighted from 10 fruits/plot.

## 2.2 Data analysis

The experiment was trialed in 5 crops and one trial was one environment. The analyze of variances were decided to random models by blocks, varieties and environments. Homogeneity of variance between crops were checked before combine analysis. Plant size, yield and yield components were analyzed by RCB design. Broad mite rates were analyzed by averaged monthly by variety and calculated the different of varieties and months by factorial in RCB with 3 blocks.

## 3. Results and Discussion

### 3.1 Plant size

The plant size (height and width) of all varieties at the first crop were highly significant at 90 to 180 day after transplantation. The 160 and 180 days height of plant from the second crop were highly significant. The width were all significant except at 30 and 90 days. The height and width of third crop were significant at 180 and 90 days. The forth crop had only significant at 150 days of the width of plants. The height o the last crop had not significantat 120 to 180 days because the serious damage of broad mite. Homogeneity of variance between crops were equaled only the height and width of 90 and 60 days. Kiriraj 4 grew the highest plant size which were 71.3 and 80.8 cm at 180 days after transplantation.

The growth of Karen chili was indeterminate type. The continually flowering stage were 70 to 90 days and harvesting date were started at 100 to 110 days after transplantation. The height and width rate had continued from 30 to 90 days at 85.2 % and 86.1% of the total rate. The reduced and stable of growth was 150 days after transplantation. (Table 1)

Meteological data during the first to third crop (June 2011 to January 2012, July 2011 to May 2012 and September 2011 to June 2012) were suitable period of healthy plant size because the plant at 180 days were less rain and serious of broad mite in January, February and April 2012. The fourth and fifth crops (November 2011 to- June 2012 and February to November 2012) were not suitable environment which high rain quantity on May, August and October 2012 and serious by broad mite. (Figure 1) Sunshine quantity was less during May to September 2012 which had only 3.1 to 6.3 hours/day and caused less useful of the growth of plants. (Figure 2)

### 3.2 The damage of broad mite

All factors were highly significance. Kiriraj 5, Kiriraj 7 and Kiriraj 4 varieties had broad mite rates, of 2.0, 2.0 and 2.1, respectively. Rain season was extended more than the other period especially during August 2012, November 2011, April and May 2012, respectively. Kongchengsin (2004) reported the serious attacked by broad mite on August. The meteological data showed the accumulated of rain from May until August 2012. The results expressed the serious damage by broad mite in rainy season the same as Kongchengsin (2004) (Table 2)

Table 1 Plant size of 8 chili varieties evaluated during June 2011 to November 2012 in Lampang province.

Periods	Height (cm.)						Width (cm.)					
Day after transplantation	30	60	90	120	150	180	30	60	90	120	150	180
1. Jun 2011 - Jan 2012	19.9	30.3	44.6	49.6	53.1	56.2	21.4	44.7	60.3	64.2	70.8	80.2
2. Jul 2011 - May 2012	20.2	42.2	47.2	56.6	57.0	59.0	20.1	51.4	53.5	61.5	72.2	71.2
3. Sep 2011 - Jun 2012	10.9	28.8	45.3	54.9	57.6	59.1	10.5	38.9	58.6	70.6	78.1	76.2
4. Nov 2011 - Jun 2012	16.9	46.3	61.8	71.0	72.4	73.3	18.8	55.6	73.3	81.5	76.8	81.7
5. Feb - Nov 2012	23.3	35.8	38.8	34.6	43.6	31.6	23.0	45.9	54.8	61.2	73.6	39.9
Period average	18.2	36.7	47.5	53.3	56.7	55.8	18.7	47.3	60.1	67.8	74.3	69.8
Increased value (cm.)		18.4	10.8	5.8	3.4	-0.9		28.6	12.8	7.7	6.5	-4.5
Increased value (%)		32.7	33.0	19.4	10.4	6.1		-1.7	26.8	40.9	18.3	11.0
90 days increase value (%)					85.2					86.1		
Varieties	Height (cm.)						Width (cm.)					
Day after transplantation	30	60	90	120	150	180	30	60	90	120	150	180
Kiriraj 1	18.5	32.2	40.7	44.6	47.2	49.7	16.8	38.7	58.3	64.6	67.4	67.7
Kiriraj 2	19.6	32.6	47.4	54.5	59.1	55.4	18.5	41.2	54.4	67.0	72.6	65.1
Kiriraj 3	17.8	33.4	44.5	53.2	55.0	52.7	18.0	44.7	55.7	62.5	74.7	65.5
Kiriraj 4	18.0	41.1	52.6	68.2	68.9	71.3	18.0	47.0	66.7	75.3	84.4	80.8
Kiriraj 5	20.1	38.5	45.6	49.9	53.8	54.8	18.7	48.6	58.3	64.6	74.4	67.4
Kiriraj 6	16.7	30.8	41.3	44.1	49.7	48.7	19.6	43.0	53.8	59.1	67.1	68.5
Kiriraj 7	15.6	34.0	41.4	49.5	49.6	48.0	18.3	54.8	59.1	71.7	71.2	68.7
Kiriraj 8	16.1	36.2	49.0	54.0	55.9	55.2	18.0	50.0	62.6	67.8	75.5	68.4
Check 1	20.9	40.5	51.0	54.3	54.8	55.4	22.2	58.0	68.6	75.1	80.0	76.9
Check 2	19.3	47.6	61.9	61.1	73.5	67.0	19.3	47.2	63.6	70.0	75.7	69.3
Average	18.2	36.7	47.5	53.3	56.7	55.8	18.7	47.3	60.1	67.8	74.3	69.8
Increased value (cm)		18.4	10.8	5.8	3.4	-0.9		28.6	12.8	7.7	6.5	-4.5
Increased value (%)		32.7	33.0	19.4	10.4	6.1	-1.7	26.8	40.9	18.3	11.0	9.4
1. F-test <sup>1/</sup>	ns	ns	**	**	**	**	ns	ns	**	**	**	**
C.V. (%)	17.0	27.5	1.3	1.1	1.1	0.9	33.2	36.3	0.7	0.7	0.5	0.4
2. F-test	ns	ns	ns	ns	**	**	ns	**	ns	**	**	**
C.V. (%)	22.8	23.1	14.9	19.8	9.3	13.1	22.4	14.2	11.3	6.9	6.2	4.3
3. F-test	ns	ns	ns	ns	ns	*	ns	ns	*	ns	ns	ns
C.V. (%)	17.7	21.0	21.3	20.8	22.5	13.9	16.4	24.0	8.2	8.0	7.5	10.5
4 F-test	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
C.V. (%)	13.2	13.3	14.0	17.9	14.4	12.1	13.1	18.0	13.2	10.5	4.7	6.3
5. F-test	**	**	**	ns	ns	ns	**	**	**	ns	**	**
C.V. (%)	12.7	11.4	11.2	24.9	6.3	22.9	11.3	10.1	13.4	17.1	4.5	9.9

<sup>1/</sup> ns, \* and \*\* = non significant and significant were at 5 % and 1 % levels

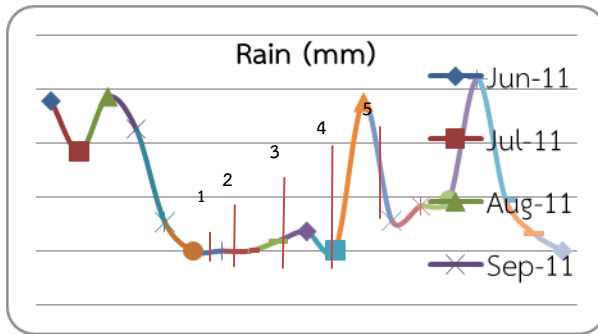


Figure 1 Total rain measured during June 2011 to December 2012 in ATRI, Lampang province.

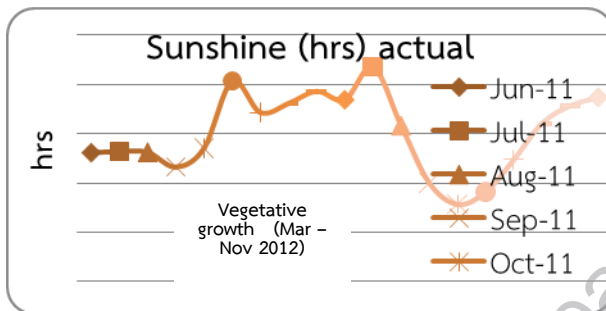


Figure 2 Actual sunshine (hours) during June 2011 to December 2012 in ATRI, Lampang province.

Table 2 Broad mite damage of 8 chili varieties during June 2011 to November 2012 in Lampang province.

Varieties	2011				2012								Average
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	
Rain (mm.)	226.5	53.9	0.1	0.0	0.0	18.5	36.3	0.7	276.5	55.6	83.4	94.3	
Kiriraj 1	2.5	1.0	2.5	1.6	0.5	1.0	2.3	4.2	4.9	3.3	0.8	5.0	2.5 ab <sup>2/</sup>
Kiriraj 2	2.5	0.3	3.3	2.3	0.5	1.7	2.4	4.1	4.8	3.7	1.4	4.9	2.7 a
Kiriraj 3	2.5	0.1	3.4	3.2	0.5	0.9	1.7	3.5	4.7	3.4	0.7	4.6	2.4 ab
Kiriraj 4	2.2	0.5	5.0	2.8	0.3	0.9	1.0	1.5	3.6	2.5	0.4	4.7	2.1 bc
Kiriraj 5	2.5	0.0	3.3	2.9	0.7	1.5	1.8	3.1	1.7	1.2	0.9	4.9	2.0 c
Kiriraj 6	2.5	1.5	4.2	1.9	0.7	2.5	3.1	4.8	2.3	0.9	1.0	5.0	2.5 a
Kiriraj 7	1.0	0.0	3.3	2.1	0.4	1.0	1.2	2.8	3.5	2.6	1.5	4.6	2.0 c
Kiriraj 8	2.3	0.1	5.0	2.8	0.7	1.6	2.1	4.5	4.2	2.5	1.1	4.7	2.6 a
Variety average	2.2	0.4	3.8	2.5	0.5	1.4	2.0	3.6	3.7	2.5	1.0	4.8	2.4
Check 1	2.5	0.3	5.0	2.8	0.5	1.9	1.5	3.4	3.9	2.7	1.1	4.7	2.5 a
Check 2	2.1	0.0	3.3	2.1	0.4	1.2	1.3	3.8	2.3	1.4	1.1	4.2	1.9 c
Check average	2.3	0.1	4.2	2.5	0.4	1.5	1.4	3.6	3.1	2.1	1.1	4.5	2.2
All average	2.2c <sup>2/</sup>	0.4 e	3.8 a	2.5 bc	0.5 e	1.4 cd	1.8 c	3.6 ab	3.6 ab	2.4 c	1.0 d	4.7 a	2.3
F-test <sup>1/</sup>													
Months	**												
Varieties	**												
M x V	**												
C.V. (%)	13.6												

<sup>1/</sup> \*\* = Sinificant was at 1 % level.

<sup>2/</sup> Any two means having a common letter were not significant different at the level 5 % level of significance .

### 3.3 Yield and yield components

Only 3 crops (June 2011 to January 2012, September 2011 to June 2012 and March to November 2012) were planted all 8 varieties and 2 checks. Homogeneity of variance equaled on fresh yield per hectare, fresh yield per plant and fruit weight. Combine analyze were significant all data except fresh yield per hectare and harvesting period. The period during September 2011 to June 2012 had the highest of fresh yield/hectare, fruit/plant, high yield weight/plant and long harvesting date. Varieties were not significant all data except fruit weight and the height of plant. Varieties were adapted for all environments in Lampang by not significant of the interaction. Kiriraj 7, Kiriraj 4 and Kiriraj 5 varieties were the highest and inferior to fresh yield as 1.6, 1.1 and 1.0

ton/hectare. Kiriraj 4 had the highest 68.9 cm of the height at the 150 days after transplant. (Table 3)

The second crop (July 2011 to May 2012) was significant to fresh yield/hectare, fresh yield/plant and fresh fruit weight. Kiriraj 7 yielded more than commercial variety equal to 6.2 and 5.1 ton/hectare and the 20.9 %. Kiriraj 1 and 5 were the lesser yield, 4.3 and 3.1 ton/hectare. The average of varieties were less fresh/dry ratio, 3.5 and 4.0, early harvesting date, 108 and 117 days after transplantation and longer harvesting period, 108 and 103 days after transplantation more than check. This crop was ideal for chili planting. The seedling stage started between July to August 2011. Vegetative and reproductive stage continued during the beginning of winter season with less rain (September to December 2011). Plant were vigorous and good fruiting. (Table 4)

Table 3 Yield and yield components of 10 chili varieties evaluated 3 crops during June 2011 to November 2012 in Lampang province.

Crops/Varieties	Yield/ha Fresh	Fruits/ plant	Fresh yield/plant	Fruit weight	Harvesting date	Harvesting period	Height (150 days)
	(t.)	(fruits)	(g.)	(g.)	(days)		(cm.)
June 2011 - January 2012	0.9	54.1 ab <sup>2/</sup>	39.9 ab	0.8 a	96.7 b	90.3	53.1 ab
September 2011 - June 2012	1.4	121.9 a	58.5 a	0.5 b	134.7 a	89.0	57.6 a
March - November 2012	0.6	38.3 b	20.8 b	0.5 b	109.7 b	82.9	43.6 c
1. Kiriraj 1	0.5	46.9	19.4	0.5 bc	113.7	93.7	47.2 d
2. Kiriraj 2	0.7	56.6	29.3	0.5 c	115.3	86.0	59.1 b
3. Kiriraj 3	0.7	62.3	26.4	0.5 c	126.7	75.7	55.0 b-d
4. Kiriraj 4	1.1	58.1	40.4	0.7 b	111.5	89.8	68.9 a
5. Kiriraj 5	1.0	73.9	43.8	0.6 bc	110.7	85.8	53.8 b -d
6. Kiriraj 6	0.8	49.4	29.5	0.6 bc	107.7	93.7	49.7 cd
7. Kiriraj 7	1.6	126.1	67.2	0.6 bc	122.3	74.2	49.6 cd
8. Kiriraj 8	0.7	50.0	29.0	0.6 bc	110.0	91.3	55.9 b-c
Check 1	1.2	102.2	50.6	0.6 bc	111.5	89.8	54.8 b-d
Check 2	1.5	88.4	61.7	1.0 a	107.7	93.7	73.5 a
F-test <sup>1/</sup>							
Crops	ns	*	*	*	*	ns	**
Varieties	ns	ns	**	ns	ns	**	
Crops x Varieties	ns	ns	ns	ns	ns	ns	ns
C.V. (%)	8.1	38.6	35.4	7.4	6.4	12.6	13.9

<sup>1/</sup> ns, \* and \*\* = non significant and significant were at 5 and 1 % level.

<sup>2/</sup> Any two means having a common letter were not significant different at the level 5 % level of significance .



Table 4 Yield and yield components of 5 chili varieties evaluated during July 2011 to May 2012 in Lampang province.

Varieties	Yield/hectare		Yield/plant		Fresh/		Harvesting	
	Fresh (t.)	Dry (t.)	Fresh (g.)	Dry	Dry ratio	date (days)	period (days)	
1. Kiriraj 1	4.3 a-c <sup>2/</sup>		1.3	179.0 bc	54.9	3.2	108.0	109.0
2. Kiriraj 2	2.8 cd	1.0	116.7 cd	39.8	3.0	108.0	112.0	
3. Kiriraj 3	2.2 d	0.8	90.8 d	31.5	2.9	108.0	98.5	
4. Kirirat 5	3.1 b-d	0.8	128.7 cd	35.5	3.6	108.0	112.0	
5. Kirirat 7	6.2 a	1.3	258.8 a	56.3	4.9	108.0	109.0	
Variety average	3.7	1.0	154.8	43.6	3.5	108.0	108.1	
Check	5.1 ab	1.4	213.8 ab	59.2	4.0	117.0	103.0	
F-test <sup>1/</sup>	*	ns	*	ns	ns	ns	ns	
C.V. (%)	9.2	10.9	8.9	10.3	9.0	2.3	5.1	

<sup>1/</sup> ns, and \* = non significant and significant were at 5 % level.

<sup>2/</sup> Any two means having a common letter were not significant different at the level 5 % level of significance .

#### 4. Conclusion

The growth of Karen chili was indeterminate type. The height and width of vegetative growth were 85.2 % and 86.1 % for the total during 0 – 90 days after transplantation. The stable of vegetative stage appeared at 150 days after transplantation. The reproductive stage flowered at 70 to 90 days and harvesting started at 100 to 110 days after transplantation. Kiriraj 5, Kiriraj 7 and Kiriraj 4 varieties were tolerant to broad mite. Kiriraj 7 yielded more than commercial variety equal to 6.2 and 5.1 ton/hectare and the 20.9 %. Kiriraj 1 and 5 were inferior yield, 4.3 and 3.1 ton/hectare. Kiriraj 1 to Kiriraj 8 were registered with the Plant Varieties Protection Division, Department of Agriculture on March 28, 2012.

#### 5. Acknowledgements

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