Phased Planting: Determining the Best Time to Plant Adlay (*Coix lacryma-jobi* L.) in Southern Bukidnon, Mindanao, Philippines

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Abstract

The Philippine government through the Department of Agriculture-Bureau of Agricultural Research spearheaded the search for additional staple to address food shortage. Adlay (*Coix lacryma-jobi* L.) was identified and promoted since 2011. However, the best time to grow the crop is a problem, thus phased (staggered) plantings/trials were conducted at CMU-AES from 2013 to 2015. Trials were laid in RCBD with the six adlay cultivars (Gulian, Tapol, Ginampay, Kiboa, Pulot and Dwarf) as treatments in four replicates.

Adlay cultivars developed 13 to 14 productive tillers/hill, with more tillers when planted during February to May; produced 120 to 186 grains/panicle across cultivars, and 90 to 235 across trials, with comparable seed weights (77g to 83g). Grain yield across cultivars ranged from 1.9 t/ha to 3.4 t/ha, with higher yields when planted towards rainy season, but yield differed across trials due to variable weather conditions. Adlay is a promising crop and can be planted anytime of the year provided soil moisture is available.

Key Words: Adlay, Job's tear, phased planting, cultivar, productive tiller, grain, staple

Introduction

The Philippines is one of the many countries that faces food insufficiency and food insecurity brought about by soil fertility decline, climate change and most especially, the burgeoning population. To address these problems, the national government searched for alternative or substitute to rice and corn, and one of the potential crops being introduced and promoted is Adlay.

Adlay (*Coix lacryma-jobi* L*),* a weed-crop, is brought into the limelight as a very promising additional food source. It is a new staple crop in some parts of Asia and is used as a cereal food the same way as rice. It is also claimed to have medicinal properties, and is also used as source of body-enhancing materials.

It also called Job's tear or Chinese pearl barley. It is upright with a freely-branching habit; grows as tall as three meters with sword-shaped leaves and propagated by seeds (Sarian, 2012). Job's tear is a short-day plant requiring high temperature, abundant rainfall and fertile soils. In the tropics, it grows from sea level to 2000m altitude, and in Africa, it is often grown in villages and abandoned fields (Jansen, 2006). In the Philippines, it is locally called *aglai, katigbi* or *tigbi* due to its tear-like grains (Reynoso, 2011; Sarmiento, 2012).

This annual crop has long been cultivated and used in traditional medicine and as nourishing food in oriental regions. It contains nutraceuticals such as vitamin E, phytosterols and squalene (Wu et al., 2007).

Adlay is a promising crop in the highlands that grows well in marginal, acidic soils and sloping areas; tolerates water logging and resistant to pests. It has also a good ratooning ability (DA-BAR, 2012; Abellon, 2013). In Southern Bukidnon, adlay thrives well and is highly productive with a growing period of about 5 to 5.5 months (Aradilla, et al, 2012; Sarucam, 2012; Bangod, 2012; Alamag, 2012). However, with climate change and

scarce rainfall, the best time to plant the crop is a problem. The significance of a planting calendar is that this indicates the customary time of planting the crop by which farmers has to follow, although the cropping pattern and planting season are highly dependent on the elements of weather, particularly the availability of soil moisture (PCSO, 1983). Thus, this research was conducted to address such problem through phased or staggered planting of the crop at two months interval.

Materials and Methods

A series of field trials were conducted at the Agricultural Experiment Center of Central Mindanao University in 2013 to 2015 following the Randomized Complete Block Design (RCBD) with the six (6) adlay cultivars (Gulian, Tapol, Ginampay, Kiboa, Pulot and Dwarf) as treatments, replicated four (4) times.

The area was divided into four blocks and each block was further subdivided into six plots with a dimension of 5m x 5m with alleyways of 2.0m and 1.75m between blocks and plots, respectively. Adlay cultivars were assigned as follows: T1 – Gulian; T2 - Tapol, T3 - Ginampay, T4 - Kiboa, T5 - Pulot and T6 - Dwarf. There were six set-ups established, once every two months and planting was done every first week of the second month.

The field was plowed and harrowed twice to break the clods and to obtain a uniform soil structure for a favorable seedbed for the plants. After the final harrowing, furrows were set 90cm apart. Adlay seeds were hydro-primed for eight hours and incubated for six hours before sowing. Pre-germinated seeds were sown at 60cm apart in the row with five seeds per hill and then covered with fine soil. At 30 DAP, thinning was done leaving only two healthy plants per hill. Hilling-up was performed immediately after thinning and subsequent spot weeding was done as the need arise. Vermi-tea home-made foliar fertilizer was

applied to the plants at monthly intervals starting at 30 DAP until flowering stage at the rate of 1L vermi-tea to 4L water applied early in the morning with the use of a knapsack sprayer.

Adlay was harvested when 80% of the grains changed in color. Harvested panicles were threshed and cleaned, and the grains were sundried for two to three days until a 14% MC was reached.

DATA GATHERED

1. Number of Productive Tillers/Hill. This was obtained from ten (10) sample hills per plot taken randomly at maturity.
2. Number of Grains/Panicle. This was obtained by counting the grains per panicle from the ten (10) sample panicles per plot.
3. Weight (g) of 1000 Seeds. This was determined by counting and weighing 1000 representatives sample seeds per treatment using a triple beam balance, adjusted to 14% MC using the formula:

   $$\text{Adjusted weight (g) of seeds} = \text{weight of 1000 seeds} \times \frac{100 - MC}{86}$$

4. Adjusted Grain Yield (kg/ha). This was determined after drying the grains at approximately 14% MC and was computed using the formula:

   $$\text{Adjusted Grain Yield (kg/ha)} = \text{plot yield (kg)} \times \frac{10000\ m^2}{\text{Effective Harvest area}} \times \frac{100 - MC}{86}$$

   where: Effective harvest area = 5.4 square meter (3m x 1.8m)

Results and Discussion

Number of Productive Tillers

The mean number of productive tillers across adlay cultivars and trials were comparable, except Trials 3 and 4 (Table 1). Across cultivars, productive tillers developed ranged from 13 to 14 pieces per hill. It was observed that adlay tends to produce more tillers when planted during drier months (February and May) than during wet season (July to December). This conforms to findings of Llemit (2013) who noted that adlay spaced at farther rows had more productive tillers than at closer spacing with 13 to 14 tillers per hill. Similar result was recorded by Monteroyo, et al (2013) on Gulian cultivar which produced 13–15 tillers/hill when applied with varying levels of vermi- compost under Musuan conditions.

Table 1. Mean number of productive tillers of six adlay cultivars, December 2013 to May 2015

Cultivar	TRIALS						MEAN
	1	2	3	4	5	6	
	Dec '13 -Jun '14	Feb '14- Aug '14	May '14- Nov. '14	Jul '14- Jan '15	Sept '14-Mar '15	Nov. '14 -May '15	
Gulian	13	23	16^{ab}	14^{ab}	7	11	**14.0**
Ginampay	14	23	13^{c}	13^{ab}	8	12	**13.8**
Tapol	13	20	16^{ab}	15^{a}	7	11	**13.7**
Pulot	13	16	19^{a}	15^{a}	7	12	**13.7**
Kiboa	15	18	17^{ab}	13^{ab}	7	10	**13.3**
Dwarf	13	20	15^{bc}	14^{ab}	10	10	**13.7**
F-test	ns	ns	*	*	ns	Ns	
CV (%)	12.9	19.06	13.90	16.19	21.5	19.74	

Means followed by common letters are not significantly different at 5% level of probability, LSD.

*- significant at 5% level of probability

ns – not significant

Number of Grains per Panicle

The mean number of grains per panicle of the test crop did not vary among cultivars and across trials, except in Trial 3. On the other hand, for Trial 6, the plants were still alive but no grains were produced due to long dry spell. Across cultivars, the number of grains per panicle ranged from 120 to 186 pieces with the Dwarf cultivar having the highest number of grains per panicle. Across trials, Dwarf cultivar produced the most number of grains per panicle since it was least referred by birds over the other cultivars (Table 2). Casite (2013) and Omblero (2012) noted no significant variations among three adlay varieties in this parameter, however, Bangod (2012) and Sarucam (2012) observed that hill distances affected the number of grains per panicle of adlay.

Table 2. Number of grains per panicle of six adlay cultivars, December 2013 to May 2015

Cultivar	TRIALS						MEAN
	1	2	3	4	5	6	
	Dec '13-Jun '14	Feb '14-Aug '14	May '14-Nov. '14	Jul '14-Jan '15	Sept '14-Mar '15	Nov '14 –May '15	
Gulian	92	180	137^{ab}	118	71	No data	120
Ginampay	116	265	124^{c}	225	99	(drought	166
Tapol	137	161	158^{ab}	180	59	affected)	139
Pulot	116	191	128^{c}	216	68		144
Kiboa	115	307	156^{ab}	201	92		174
Dwarf	163	306	131^{bc}	179	150		186
F-test	ns	ns	*	ns	ns		
CV (%)	21.19	13.67	16.31	20.15	18.25		

Means followed by common letters are not significantly different at 5% level of probability, LSD.
*- significant at 5% level of probability
ns - not significant

Weight of 1000 Seeds

The average weight of 1000 seeds across treatments and trials were comparable which ranged within 77g to 83 g. Tapol and Kiboa had heavier grains (83g), followed by Gulian and Pulot (82g), while grains of Ginampay and Dwarf weighed only 79g and 77g, respectively. Across trials, adlay planted during September had heavier grains than the rest of the trials (Table 3). Amor (2012) noted that Gulian, Ginampay and Tapol did not differ significantly on the weight of 1000 grains. Coles (2013) noted significant variations in seed weights but Gulian had heavier grains.

Table 3. Average weight (g) of 1000 seeds of six adlay cultivars, December 2013 to May 2015

Cultivar	TRIALS						MEAN
	1	2	3	4	5	6	
	Dec '13-Jun '14	Feb '14-Aug '14	May '14-Nov. '14	Jul '14-Jan '15	Sept '14-Mar '15	Nov. '14 –May '15	
Gulian	81	79	79	84	88	No data	82
Ginampay	67	80	84	80	84	(drought	79
Tapol	78	88	82	81	86	affected)	83
Pulot	76	75	85	86	88		82
Kiboa	87	89	77	81	80		83
Dwarf	76	80	78	76	75		77
F-test	ns	ns	ns	ns	ns		
CV (%)	10.11	18.90	15.77	3.39	13.76		

ns – not significant

Grain Yield

The mean grain yield of the six adlay cultivars did not significantly differ, except in Trials 3 (May 2014 and November 2014) and Trial 4 (July 2014 to January 2015). For Trial 3, Dwarf had the highest yield (4.95 t/ha) compared to the rest of the cultivars tested with yield ranges of around 1.2 t/ha to 1.9 t/ha. For Trial 4, almost all varieties obtained yields

within 2.9 to 3.4 t/ha being exhibited by Dwarf, Pulot, Kiboa and Ginampay. Gulian and Tapol had comparable yields of 2.3 t/ha. On average across trials, the yield of the different cultivars ranged from 1.9 t/ha (Tapol) to 3.4 t/ha (Dwarf) (Table 4).

The yield of the test crops were affected by climatic and environmental factors. Adlay planted and grown in months with limited rainfall had lower yields (Trials 1, 3, 5). Further, grains of the test crops were attacked by rice birds during off-seasons indicating that rice birds considered adlay as alternate food, particularly Gulian, Tapol, Kiboa, Ginampay and Pulot with percentage infestations of 59%, 55%, 51%, 47% and 46%, respectively. Dwarf cultivar was least preferred by birds with only 31% infestation because of its upright flag leaf. Moreover, during dry, hot spells (Trial 6), adlay plants were severely affected due to less or no available soil moisture. According to Tollenaar, et al (1978), even minor drought during physiologic stages of the crop can reduce the yield significantly. Amor (2012) reported that Gulian obtained the highest grain yield with 3,503 kg/ha followed by Tapol with 2,632.24 kg/ha. Coles (2013) noted that Gulian was the highest yielder when applied with organic fertilizers. Similarly, Calo et al (2014) observed that weed-free adlay plots obtained the highest yield of 2.9 t/ha followed by hilling-up at 30 DAP with 2.3 t/ha under Southern Bukidnon conditions.

Table 4. Grain yield (t/ha) of six adlay cultivars, December 2013 to May 2015

Cultivar	TRIALS						MEAN
	1	2	3	4	5	6	
	Dec '13-Jun '14	Feb '14-Aug '14	May '14-Nov. '14	Jul '14-Jan '15	Sept '14-Mar '15	Nov. '14 –May '15	
Gulian	1.17	4.58	1.42^{ab}	2.34^{b}	0.81	No data	2.06
Ginampay	1.38	5.28	1.88^{a}	2.93^{ab}	1.02	(drought	2.50
Tapol	1.37	4.09	1.27^{b}	2.32^{b}	0.78	affected)	1.97
Pulot	1.12	4.38	1.20^{c}	3.10^{ab}	0.03		2.12
Kiboa	1.42	5.84	1.90^{a}	3.04^{ab}	0.94		2.63
Dwarf	1.01	6.24	4.95^{a}	3.41^{ab}	1.51		3.42
F-test	ns	ns	*	*	ns		
CV (%)	20.46	14.54	24.10	20.17	11.76		

Means followed by common letters are not significantly different at 5% level of probability, LSD.
*- significant at 5% level of probability
ns – not significant

Effect of Climatic Factors on Grain Yield

Across trials, the relative humidity and rainfall patterns during the growing period of Adlay significantly influenced its growth and development, and eventually the yield. On the other hand, grain yield was less affected by air temperature (Table 5). According to Elston (1983), climate and weather help determine cropping systems and yields of individual crops. Likewise, Chandrasekaran, et al (2010) mentioned that weather plays a decisive role in crop production and this contributes to 50% variations. Gooding (2010) opined that for well-adapted crop varieties, yield and quality can still be affected strongly by weather and by agronomic interventions. Heat and drought during grain filling, availability of nutrients, and control of pests highly influence grain quality.

Table 5. Correlation of climatic factors (rainfall, RH and temperature) on the yield of six adlay cultivars across trials

Parameters	Adlay cultivars					
	Gulian	Ginampay	Tapol	Pulot	Kiboa	Dwarf
Rainfall	0.155087968	0.17151799	0.14583566	0.189497	0.1665346	0.28402522
Relative Humidity (RH)	0.046164512	0.0685151	0.03916372	0.109685	0.0580321	0.17045915
Temperature	-0.058711984	-0.05872298	-0.0704402	-0.0862	-0.05958	-0.0216811

Conclusions and Recommendation

The six adlay cultivars can be grown anytime of the year in Southern Bukidnon, provided there is enough moisture in the soil. All cultivars are very promising, however Dwarf cultivar obtained the highest yield in 4 out of 5 successful trials. On the other hand, grain yield of adlay was noted to be higher when planted towards the rainy season, and provided that, grain development is synchronous with rice to minimize bird damage, particularly in areas near lowland rice field.

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