



Growth and yield response of chickpea (*Cicer arietinum* L.) to frequency of irrigation under Philippine condition

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ABSTRACT. Growing chickpea in the Philippines is a new venture although chickpea is widely consumed by Filipinos, the demand is met only through import. The study was conducted to determine the growth and yield response of chickpea to frequency of irrigation that would ensure higher yield under Philippine condition. Results revealed that the effect of varieties and the interactive effect of varieties and irrigation were significantly different on the agronomic character and yield traits of chickpea except for individual plant yield. Moreover, the different frequency of irrigation has significantly influenced the number of days from planting to 50% flowering, days from planting to harvesting, pods/plant, filled pods, weight of 100 seeds, and yield/ha. Among the different varieties and irrigation treatments, ICCV 2 with irrigation of every 15 days produced the highest yield of 3,573.55 kg/ha.

Keywords: Chickpea, *Cicer arietinum*, irrigation frequency, Philippines.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is a small bushy annual plant widely cultivated in warm temperate and tropical areas for its edible seeds. It is the 3rd most important food legume grown globally and the highest nutritional compositions of any dry edible legume. India is the largest chickpea producing country covering 64% of the global chickpea production (Gaur *et al.*, 2010). The plant is free from various anti-nutritional factors and has high protein (23%) content, carbohydrates (64%), dietary fiber content and rich in minerals and vitamins. The seeds are processed into flour for preparing a variety of food products, and could be used as supplemental feeds for poultry and livestock. The fresh green chickpeas can be roasted or cooked as vegetable or as finger foods.

According to Knott (1957), frequency of irrigation depends on the total supply of available moisture reached by the roots and the amount of water used. The first is affected by soil types, the depth of watered soil, and dispersion of roots. The latter is influenced by weather conditions and the age of the crop. Effective irrigation will influence the entire growth process from seedbed preparation, germination, root growth, nutrient utilization, plant growth and re-growth, yield and quality. Though scientists have determined water requirement of most common crops, Donahue and Shickluna (1971) reported that there are still variations due to the differences in the soil temperature, related humidity, wind movement, and soil fertility.

Growing chickpea in the Philippines is a new venture although chickpea is widely consumed by Filipinos, the demand is met only through import. The introduction of new high yielding varieties from ICRISAT coupled with the generation of location

specific technologies for the highlands of the Cordillera Administrative Region (CAR), chickpea could become a major cash earner. The study was conducted to determine the growth and yield response of chickpea to frequency of irrigation that would ensure higher yield under Philippine condition.

MATERIALS AND METHODS

The study was conducted in sandy loam soil at the Benguet State University, La Trinidad, Benguet, Philippines in November 2009 using three cultivars each of *kabuli* and *desi* type chickpeas. The experiment were laid out in a Randomized Complete Block Design (RCBD) with four irrigation treatments (during sowing, branching and flowering stage; every 5 days; every 10 days; and every 15 days) as Factor A and six cultivars (Desi – ICCV 93952, ICCV 93954, ICCV 06102 and Kabuli – ICCV 2, ICCV 95334, ICCV 07307) as Factor B. Each variety was sown at a planting distance of 30 cm between rows and 20 cm between hills in three replications. The size of the treatment plot is 1 m x 3 m. The volume of water applied during frequency of irrigation was 32 liters per plot from planting until harvesting while flooding treatment is implemented during sowing, branching stage, and flowering stage. Other recommended agronomic practices were followed uniformly to all the treatments. Data on days to 50% flowering, plant height at 50% flowering (cm), days to harvesting, number of lateral stems, number of pods/plant, number of filled and unfilled pods/plant, weight of 100-seeds (g), and yield per plant (g) were collected on 5 sample plants within each treatment. Total seed yield (kg/ha) was calculated on plot basis. To detect the direct and interactive effects of the varieties and irrigation treatments,

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analysis of variance for split plot design was used to determine the best treatment combination in increasing seed yield of chickpea.

RESULTS AND DISCUSSIONS

Days to flowering

Effect of variety : The study showed that the number of days to 50% flowering were significantly different among the varieties (Table 1). However, ICCV 2 was the earliest to flower at 45 days (Table 2) while the longest to attain 50% flowering was ICCV 93952 (67 days).

Effect of irrigation : There was a significant difference on the days to 50% flowering as affected by irrigation (Table 1). Chickpea plants irrigated every 5 days was the earliest to flower at 53.35 days (Table 2), while those irrigated during sowing, branching stage, and flowering stage, were the latest to attain 50% flowering at 58 days.

Interactive effect of variety and irrigation : There was a significant interaction among the varieties with the different frequencies of irrigation on the days to 50% flowering (Table 1). ICCV 95334 with irrigation during sowing, branching, and flowering stage produced the least number of days to 50% flowering at 42 days (Table 2) while ICCV 93952 have the longest days to 50% flowering at 72 days.

Plant height at 50% flowering

Effect of variety : There was a significant difference observe on the plant height of among chickpea varieties at 50% flowering (Table 1). ICCV 95334 was the tallest among the varieties at 45.12 cm (Table 2) while ICCV 2 had the shortest plant height at 35.68 cm.

Effect of irrigation : There were no significant differences on the plant height of chickpea varieties at 50% flowering as influenced by the different frequency of irrigation (Table 1).

Interactive effect of variety and irrigation : Statistical analysis revealed that there was a significant interaction effects noted among the varieties and frequency of irrigation as to the plant height at 50% flowering (Table 1). ICCV 95334 with irrigation of

every 5 days give the highest height at 50.14 cm (Table 2) whereas ICCV 2 irrigated every 15 days produced the least height at 31.7 cm.

Days to harvesting

Effect of variety : Days from planting to harvesting are significantly different among the varieties (Table 1). The *kabuli* varieties (ICCV 2, ICCV 95334, ICCV 07307) were harvested earlier at 123.5 days (Table 2) while the *desi* varieties (ICCV 93952, ICCV 93954, ICCV 06102) were harvested 14 days later (137.5).

Effect of irrigation : Significant differences were observed on the days to harvesting as affected by frequency of irrigation (Table 1). Plants irrigated every 15 days was harvested earlier at 129 days (Table 2) while through flooding, harvesting was delayed by 3 days.

Interactive effect of variety and irrigation : A significant difference among the two types of chickpea (*kabuli* and *desi*) was influenced by irrigation on the days to maturity (Table 1). The study showed that the *kabuli* varieties irrigated every 15 days were the earliest to harvest at 123 days (Table 2) while the *desi* type irrigated from planting, branching stage, and flowering stage were the latest to be harvested at 138 days.

Lateral branch

Effect of variety : The study shows that there was a significant difference on the number of lateral branches among the varieties (Table 1). ICCV 06102 had produced the highest number of stems at 4.28 (Table 2) while ICCV 95334 produced the lowest number of stems at 3.36.

Effect of irrigation : The average number of lateral branches was not significantly influenced by any irrigation treatments as revealed in Table 1.

Interactive effect of variety and irrigation : The study revealed that there was a significant interaction effects among the chickpea varieties and different frequencies of irrigation on the production of lateral branches (Table 1). The highest number of lateral branches (4.78) produced was ICCV 06102 with irrigation during sowing, branching and flowering stage

Table 1. ANOVA of the direct and interactive effect of variety and irrigation at 5% level of significance

Treatment	Days from planting to 50% flowering (no.)	Plant height at 50% flowering (cm)	Days from planting to harvesting (no.)	Lateral branches at flowering (no.)	Pods			Weight of 100-seeds (g)	Yield per	
					Plant (no.)	Filled pods (no.)	Unfilled pods (no.)		Plant (g)	Ha (kg)
Effect of variety	<0.0001*	<0.0001*	<0.0001*	<0.0001*	<0.0001*	<0.0001*	0.001*	<0.0001*	0.50ns	<0.0001*
Effect of irrigation	<0.0001*	0.27ns	<0.0001*	0.15ns	<0.0001*	<0.0001*	0.37ns	<0.0001*	0.50ns	<0.0001*
Interactive effect of variety and irrigation	<0.0001*	<0.0001*	<0.0001*	0.0091*	<0.0001*	<0.0001*	0.002*	<0.0001*	0.47ns	<0.0001*

* - significant; ns – not significant

Table 2. Mean attributes of chickpea as influenced by the direct and interactive effects of variety and irrigation

Agronomic trait	Factor	Treatment	Mean
Days from planting to 50% flowering	Effect of variety	ICCV 2	45.19
	Effect of irrigation	Irrigation of every 5 days	53.35
	Variety and irrigation	ICCV 95334 + irrigation during sowing, branching stage, flowering stage	42
Plant height at 50% flowering (cm)	Effect of variety	ICCV 95334	45.12
	Variety and irrigation	ICCV 95334 + irrigation every 5 days	50.14
Days from planting to harvesting	Effect of variety	ICCV 2, ICCV 95334, and ICCV 07307	123.5
	Effect of irrigation	Irrigation every 15 days	129
	Variety and irrigation	ICCV 2, ICCV 95334, and ICCV 07307 + irrigation every 15 days	123
Lateral branches at flowering (no.)	Effect of variety	ICCV 06102	4.28
	Variety and irrigation	ICCV 06102 + irrigation during sowing, branching stage, flowering stage	4.78
Pods/plant (no.)	Effect of variety	ICCV 2	304.17
	Effect of irrigation	Irrigation every 15 days	379.63
	Variety and irrigation	ICCV 93954 + irrigation every 15 days	526.11
Filled pods/plant (no.)	Effect of variety	ICCV 2	289.62
	Effect of irrigation	Irrigation every 15 days	362.11
	Variety and irrigation	ICCV 93954 + irrigation every 15 days	496.45
Unfilled pods/plant (no.)	Effect of variety	ICCV 95334	10
	Variety and irrigation	ICCV 95334 + irrigation during sowing, branching stage, flowering stage	8.11
Weight of 100-seeds (g)	Effect of variety	ICCV 2	78.12
	Effect of irrigation	Irrigation every 15 days	103.78
	Variety and irrigation	ICCV 93954 + irrigation every 15 days	135.15
Yield/ha (kg)	Effect of variety	ICCV 2	2,456.11
	Effect of irrigation	Irrigation every 15 days	2,853.33
	Variety and irrigation	ICCV 2 + irrigation every 15 days	3,573.55

(Table 2) while ICCV 95334 irrigated during sowing, branching and flowering stage give the least number of lateral branches at 2.67.

Pods per plant

Effect of variety : The average number of pods per plant was significantly different among the varieties (Table 1). Results revealed that ICCV 2 produced the highest number of pods/plant at 304 (Table 2) whereas, ICCV 95334 produced the lowest number of pods/plant at 132.

Effect of irrigation : There were significant differences among the varieties as affected by the different irrigation treatments as shown in Table 1. The study showed that irrigation of every 15 days produced the highest number of pods/plant at 379 (Table 2) while chickpea irrigated every 5 days produced the least quantity of pods/plant at 133.

Interactive effect of variety and irrigation : The study showed that there were significant differences observed by the two factors; variety and frequency of irrigation on the number of pods/plant (Table 1). ICCV 93954 irrigated every 15 days had produced more number of pods/plant (526) as shown in Table 2 while ICCV 93952 irrigated every 5 days produced the lowest number of pods at 101/plant.

Filled pods

Effect of variety : Table 1 shows a significant difference on the number of filled pods/plant among the varieties (Table 1). ICCV 2 had the highest number of filled pods with 289/plant (Table 2) while variety ICCV 95334 had the lowest number of filled pods at 122.

Effect of irrigation : Result shows a significant difference on the number of filled pods as influenced by irrigation (Table 1). Chickpea irrigated every 15 days provided the highest number of filled pods at 362 (Table 2) while plants irrigated at closer interval (every 5 days) produced the least number of filled pods at 125.

Interactive effect of variety and irrigation : The interactive effect of variety and irrigation were significantly different on the number of filled pods/plant as shown in Table 1. Results showed that ICCV 93954 irrigated every 15 days give the highest number of filled pods at 496 (Table 2) whereas ICCV 93954 irrigated every 5 days produced the lowest number of filled pods at 49/plant.

Unfilled pods

Effect of variety : The study showed that the six varieties were significantly different on the number of unfilled pods/plant (Table 1). ICCV 95334 give the lowest number of unfilled pods at

10/plant (Table 2) while ICCV 93954 produced the highest number of unfilled pods at 22/plant.

Effect of irrigation : No significant difference was observed among the different irrigation treatments on the number of unfilled pods as revealed in Table 1.

Interactive effect of variety and irrigation : The study revealed that the number of unfilled pods was significantly influenced by the interaction of variety and irrigation as shown in Table 1. ICCV 95334 irrigated during sowing, branching, and flowering stage give the least number of unfilled pods at 8/plant (Table 2) while ICCV 93954 irrigated every 5 days had the highest number of unfilled pods at 30/plant.

Weight of 100 Seeds

Effect of variety : The research shows that there were significant differences on the weight of 100 seeds among the different varieties (Table 1). ICCV 2 gave the highest weight of 100-seeds at 78 gm (Table 2) while ICCV 93954 give the lowest weight of 58 gm.

Effect of irrigation : Significant differences were observed on the weight of 100 seeds of chickpea as affected by the different irrigation level (Table 1). Chickpea plants irrigated every 15 days obtained the heaviest 100-seeds weight of 103.78 gm (Table 2) whereas chickpea plants irrigated every 5 days produced the least weight of 34.91 g/100-seed mass.

Interactive effect of variety and irrigation : Statistical analysis revealed that there was a significant interaction effects among the varieties and irrigation treatments on the weight of 100-seeds as revealed in Table 1. ICCV 93954 with irrigation of every 15 days provided the highest weight of 135.15/100 seeds (Table 2) while ICCV 93954 irrigated every 5 days produced the least weight of 18 g/100 seeds.

Yield per plant : There were no significant differences among the varieties, irrigation frequencies, and interactive effect of varieties and irrigation on the yield/plant as shown in Table 1.

Yield per hectare

Effect of variety : Table 1 show that there were significant differences on the calculated yield/ha of chickpea varieties as revealed in Table 1. ICCV 2 had the highest computed seed yield of 2456.11 kg/ha (Table 2) whereas ICCV 95334 obtained the lowest seed yield at 1288.69 kg/ha.

Effect of irrigation : The study revealed that the different frequencies of irrigation have significant effect on the seed yield of chickpea (Table 1). Chickpea that were irrigated every 15 days produced the highest seed yield of 2828.33 kg/ha (Table 2) while chickpea irrigated every 5 days had the lowest seed yield of 1018.24 kg/ha.

Interactive effect of variety and irrigation : There were

significant differences observed between the chickpea varieties and different frequencies of irrigation on the yield/hectare (Table 1). ICCV 2 irrigated every 15 days give the highest yield at 3573.55 kg/ha (Table 2) while ICCV 93954 irrigated every 5 days have the least yield of 503.65 kg/ha.

CONCLUSIONS

In this study, it was observed that irrigation has influenced the growth and yield performance of chickpea. Irrigation interval of every 5 and 10 days influenced the vegetative growth (plant height) but provided poor yield and yield traits of chickpea which conforms to the statement of Chapman and Carter (1976); and Blackwell and Wells (1983) which observed that root growth slows down as the oxygen diffusion rate in the soil falls below that required to sustain normal rate of oxygen uptake by the roots for plants respiratory activities. However, irrigation frequency of every 15 days and during sowing, branching and flowering stages significantly influenced the plant growth and yield traits of the crop which conforms to the findings of Chaudhari *et al.* (1998) where irrigation during flowering and pod development increased seed yield by as much as 9%.

Of the 6 varieties and 4 irrigation frequencies tested, ICCV 2 with irrigation of every 15 days produced the highest yield (3,573.35 kg/ha), have the least number of days to 50% flowering (45.19), least number of days to harvesting (123 days), produced the highest number of pods (304), have more number of filled pods (290), and give the highest weight of 100 seeds (78.12). The yield factor was correlated with the number of pods, filled pods, and weight of 100 seeds of ICCV 2 which conforms to the findings of Chaudhari *et al.* (1998). Likewise, it is further concluded that chickpea plants can tolerate low levels of soil water moisture and can still produce higher yield.

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