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Original Research Article

Effect of Carrageenan Plant Growth Regulator on the Growth and Yield of Three Peanut (*Arachis hypogaea* L.) Varieties Under Wet Season Planting

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Abstract: The study was conducted at the experimental farm of the Mariano Marcos State University, Dingras, Ilocos Norte from August to December 2018. The area is rainfed and was grown with corn during dry season. The adjoining fields of the experimental area were planted with soybean, cowpea and peanut during the conduct of the study. The study was conducted to determine the yield and growth performance of the peanut varieties applied with Carrageenan Plant Growth Regulator (CPGR); to identify the best variety that would produce the highest yield under wet season cropping; and to determine the production economics of peanut applied with CPGR. The study was laid out in a 2 factorial RCBD design with three replications. The varieties: Farmers' variety (Ilocos Red), improved peanut varieties (NSIC Pn 9 and NSIC Pn 12) was assigned as factor A, and CPGR (with and without) as factor B.

Keywords: Different Peanut Varieties, Carrageenan Plant Growth Regulator, Wet Season Cropping.

INTRODUCTION

Peanut *(Arachis hypogaea L.)* or groundnut is one of the most in-demand legumes because of its many uses as human food and animal feed, being an excellent source of protein. The introduction of new and improved peanut varieties with good performance in some parts of the country is needed where peanut products are commercially popular. Testing of these varieties should include not only an evaluation of its yield but also its resistance to insect pests under wet season condition (Bernabe *et al*., 2015).

Peanut is among the versatile and economically important agriculture crops in the world. It is commonly grown in countries with warm climates and generally grows and yields well in loose soils.

Peanut production in the country had suffered a significant decline in the past several years (Bureau of Agricultural Statistics, 2001-2011) and one of the contributing factors in the low production and profit of farmers is the occurrence of insect pests and diseases. A yield reduction of about 30-50% is due to the incidence of diseases and approximately 10% is due to insect pests when left uncontrolled (Crop Profile in Peanut, 2000).

Varieties adapted to both dry and wet season plantings are desired. High yield, resistance to drought during the dry season and flooding during the wet season, and resistance to pests and diseases are important considerations in choosing a variety to plant. A variety of high shelling percentage character should also be considered where nuts are in demand in the market. Proper selection of varieties that is suitable both in dry or wet season is important (La Union Technoguide, Mungbean-Peanut Production).

The study was conducted to determine the growth and yield performance of peanut varieties applied with Carrageenan Plant Growth Regulator (CPGR) grown during the wet season.

METHODOLOGY

Locale of the Study

The study was conducted at the experimental farm – satellite campus of the College of Agriculture, Food and Sustainable Development (CAFSD), Mariano

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Marcos State University, located at Brgy. Puruganan, Dingras, Ilocos Norte (Plate 1). Based on the physical and chemical analyses of the soil samples from the area, results showed that the soil texture is light and has 6.20 pH level, has 1.77% organic matter, 0.0885% available nitrogen, 0.00 ppm Phosphorus and 230.81 ppm Potassium.

The area is rainfed supported with groundwater as the source of irrigation through shallow tubewell. The adjoining fields of the experimental area were planted with soybean, cowpea, and peanut during the conduct of the study. Some trees were also planted at the western part of the site.

Research Design and Variables

The field experiment was laid out following the 2 factorial RCBD design with three replications. Every replication was composed of 6 experimental plots. An experimental plot had a total area of 8 m^2 (2m x 4m). The experimental treatments were assigned as follows: variety, as factor A, and CPGR as factor B. Each replication had a total area of 48 m^2. The plots were spaced at 0.75m between rows, 0.30m between hills, 1m between replication and 0.50m between treatments. Each plot consisted of four rows.

The following were the treatments:

Factor A: Variety

V1 – Farmer's variety (Ilocos Red)
V2 – improved Peanut variety (NSIC Pn 9)
V3 – Improved peanut variety (NSIC Pn 12)

Factor B: CPGR

1 - With CPGR
2 - Without CPGR

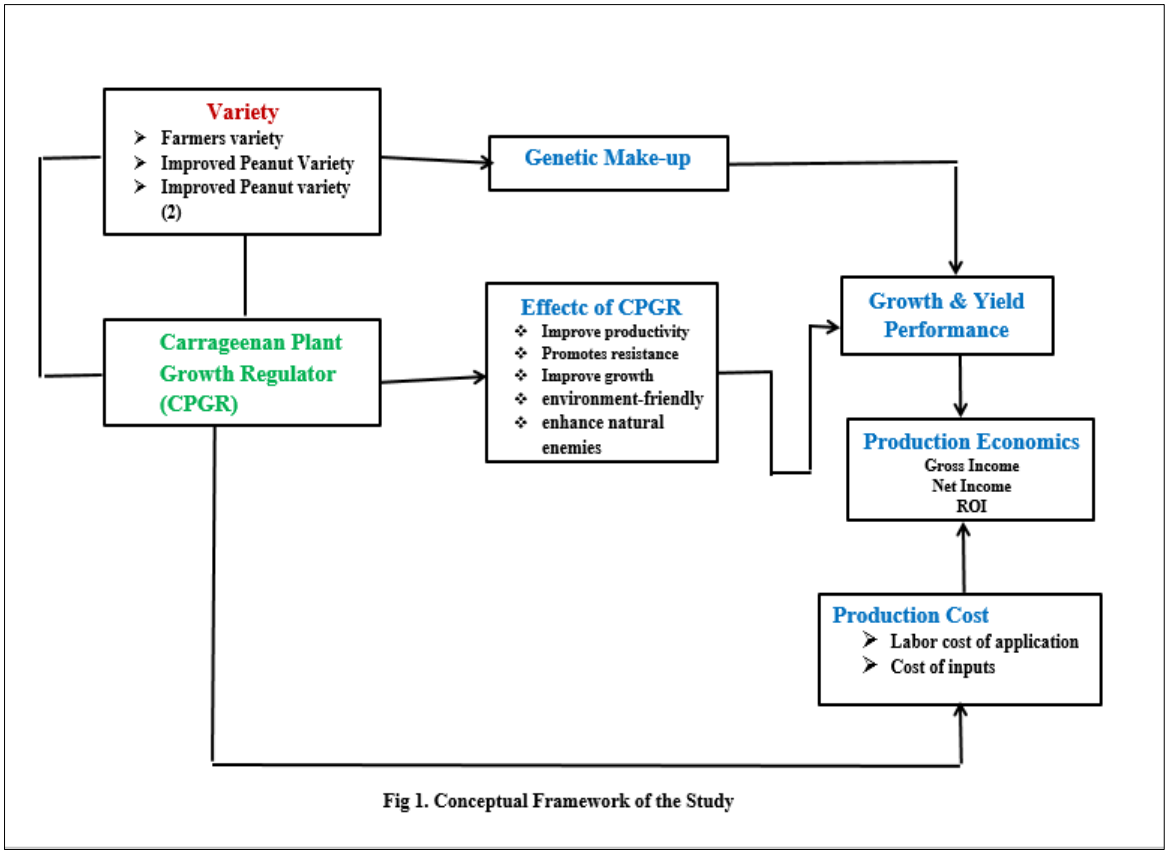

Figure 1: Conceptual Framework of the Study

Application of CPGR

CPGR was sourced out from the Department of Agriculture-Regional Office1. The application was done three times at vegetative stage, pod formation, and pod filling through foliar application at the rate of 12 L/ha^{-1}.

Data Gathering Procedures

The following data were gathered during the conduct of the study: the agro climatic data, growth and yield parameters, and the cost and return.

Profitability Analysis

The cost of production in conducting the study was properly recorded. Cost and return analysis was computed based on actual expenses incurred throughout the conduct of the study. This was projected in a per hectare basis. The economic analysis per hectare was computed by the following formulas;

Gross Income = Yield (kg) x Price/kg (Php)
Net Income = Gross Income – Total Cost of Production
Cost/kg pod (Php/Kg) = Total Cost of Production/Yield

Benefit Cost Ratio (BCR) = Net Income/Total Cost of Production x 100

Data Analysis

All pertinent observations and data gathered were recorded and statistically analyzed using the analysis of variance (ANOVA) for RCBD Two Factorials Design using Statistical Tool for Agricultural Research (STAR). Comparison of treatment means was done using Least Significant Difference (LSD) test.

RESULTS AND DISCUSSION

Plant Growth Parameters

Presents the results of the different plant growth parameters of peanut varieties as affected with Carrageenan Plant Growth Regulator (CPGR) grown during wet season.

Table 1: Emergence, flowering and peg formation from DAS for peanut varieties grown during wet season in response to CPGR

Treatment	Days To		Peg Formation
	Emergence	Flowering	
Variety (A)	*	*	**
1 Ilocos Red	7.02a	22.98a	29.98b
2 NSIC Pn9	6.77b	22.77b	29.73a
3 NSIC Pn12	6.96a	22.96a	29.98b
CPGR (B)	*	*	*
With	6.68	22.68	13.68
Without	7.15	23.12	14.15
CV (a)	4.43	1.06	0.48
CV (b)	6.38	1.46	1.47

ns-not significant
**-significant at 1% level
*-significant at 5% level
CV- Co-efficient of variation
Means with the same letter within each column are not significantly different using the LSD test.

The result shows significant differences were observed on the number of days from sowing to 50% emergence on the different varieties of peanut planted as shown from the table above (Table 1). Among the three varieties used, NSIC Pn9 was the earliest to emerge at an average day of 6.77, followed by NSIC Pn12 with an average of 6.96 days and the Ilocos Red was the latest to emerge with an average of 7.02 days.

In the application of CPGR, significant differences were also observed on the plants applied with CPGR. Plants applied with CPGR emerged earlier with an average of 6.68 days than the plants without CPGR which emerged after 7.15 days.

The seedling emergence that ranges from 6-7 days was comparable to the study of Prasad *et al*., (2011) wherein peanut emergence takes 3-5 days from sowing at its most favorable condition of 30ºC in light-textured soil. The two day-delay as compared to the expected days-to-emergence can be attributed to the short period of days with sunlight and long period of days with cloudy atmosphere and heavy rains, wherein the month of August has recorded the highest number of rainfall that makes the texture of the soil heavy, making it hard for the seedlings to emerge.

In the days to flowering, significant differences were observed on the days of sowing to 50% flowering on the different varieties of peanut planted applied with carrageenan plant growth regulator. Among the three varieties used, variety 2 (NSIC Pn9) were the earliest to flower at an average day of 22.77, followed by variety 3 (NSIC Pn12) with an average of 22.96 days, and variety 1 (Ilocos red) was the latest to flower with an average of 22.98 days (Table 1). In the application of CPGR, significant differences were also observed. Plants applied with CPGR flowered earlier with an average of 22.68 days than the plants without CPGR, flowering an average of 23.12 days. The gathered data under the number of days from sowing to 50% flowering ranging from 22 to 24 days after sowing is earlier than the expected days in comparison to the study of Parsad *et al*., (2011) which ranged from 25-30, which can be justified by the maximum temperature of 30ºC as shown in the plants applied with CPGR were the first to flower as supported by the study conducted by Aurige *et al*., on the effect of carrageenan on the morpho-agronomic characteristics of mungbean. Their study showed that the mungbean applied with 60 ppm of carrageenan proved to be the most effective in inducing plants to flower (Aurige, *et al*., 2019).

Table 1 shows that, highly significant differences were observed a week after 50% flowering on the different varieties of peanut planted. Among the three varieties used, variety 2 (NSIC Pn9) had the earliest peg formation at average days of 29.73, followed by variety 3 (NSIC Pn12) and variety 1 (Ilocos Red) were the latest to form pegs with an average of 29.98 days.

Pegs are crucial for the growth of the developing pods as well as the plants. It develops root hair-like structures that facilitate absorption of adequate amounts of moisture and nutrients from the soil, required for the overall plant growth. (Kumar, *et al*., 2019).

In the application of CPGR, significant differences were also observed. Plants applied with CPGR formed pegs earlier with 13.68 days than the plants without CPGR with an average of 14.15 days.

Vine length at 60 days after sowing (DAS) shows significant differences among the plants, while there are no significant differences observed at 90 days after sowing on the different varieties of peanut planted as shown in Table 2. Ilocos Red recorded the tallest plant height at 60 DAS with an average of 48.71cm, followed by NSIC Pn12 with an average of 48.605cm. Variety NSIC Pn9 recorded the shortest plant height with an average of 44. 98cm. NSIC Pn12, on the other hand, recorded the longest vine length with an 81.73cm at 90 DAS; followed by NSIC Pn9 with an average of 79.13. Ilocos Red had the shortest vine length with an average of 75.68cm.

On the other hand, with the application of CPGR at 60 DAS, no significant differences were observed. Plants applied with CPGR had the longest plants with an average of 48.16cm than plants without CPGR with 46.71cm.

Table 2: Vine length (cm) at 60 and 90 DAS and biomass (kg ha^{-1}) for peanut varieties grown during wet season in response to CPGR

Treatment	Vine Length (Cm)		Biomass (Kg Ha^{-1})
	60 Das	90 Das	
Variety (A)	*	ns	**
1 Ilocos Red	48.71ab	75.68a	1211.86b
2 NSIC Pn9	44.98b	79.13b	1371.54b
3 NSIC Pn12	48.605a	81.73a	1548.00a
CPGR (B)	ns	ns	ns
1 With CPGR	48.16a	80.28a	1413.58a
2 Without CPGR	46.71b	77.48b	1335.13b
A x B	*	ns	ns
CV (a)	10.68	12.15	10.04
CV (b)	20.81	18.82	11.48

ns-not significant
**-significant at 1% level
*-significant at 5% level
CV- Co-efficient of variation
Means with the same letter within each column are not significantly different using LSD test.

Based from the findings of Saucedo *et al*., (2015), that the application of CPGR improved the growth of *Pinus radiate* by inducing the accumulation of C, N, and S.

Interaction effects were significantly observed between the variety and the application of CPGR. At 60 DAS, significant differences as shown in Figure 2, it was observed in variety 1 (Ilocos Red), having the longest average vine length of 48.71cm, followed by variety 3 (Pn12) with an average of 48.605cm and variety 2 (NSIC Pn9) having the least average vine length of 44.98cm.

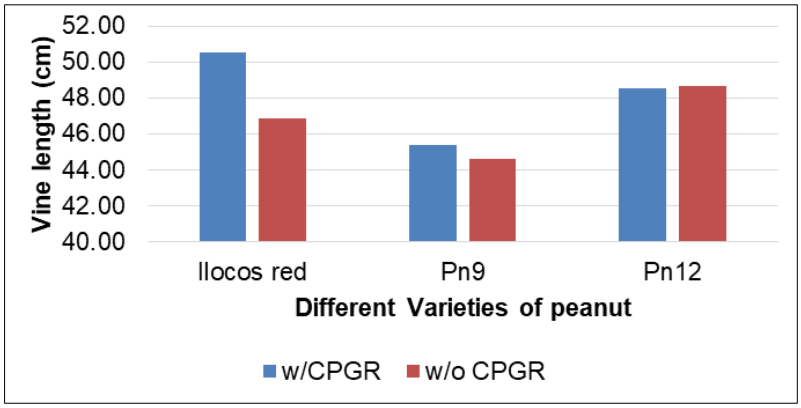

Figure 2: Interaction effects between varieties and application of CPGR on vine length of peanut at 60 DAS, ws 2018

Plants treated with CPGR showed increased activity of several NAD(P)H-synthesizing enzymes involved in the basal metabolism (Saucedo *et al*., 2015). On the plants without the application of CPGR at 60 DAS, variety 3 plants (NSIC Pn12) were longest with 48.64cm; followed by variety 1 (Ilocos Red) with an average vine length of 46.87cm; and variety 2 (NSIC Pn9) had the shortest vine length with an average of 44.6cm.

At 90 DAS, plants applied with CPGR were taller with an average of 80.28 cm than plants without CPGR with 77.48cm. Based from the findings of Saucedo *et al*., (2015), that the application of CPGR improved the growth of Pinus radiate by inducing the accumulation of C, N, and S.

Results showed significant differences on plant biomass of the peanut varieties applied with CPGR (Table 2). It shows that variety 3 (NSIC Pn12) obtained the highest biomass of 1,548 (kg ha-1) followed by the biomass of variety 2 (NSIC Pn9) with 1,371.54 (kg ha-1); and variety 1 (Ilocos Red) had the lowest biomass of 1,211.86 (kg ha-1).

In the application of CPGR, no significant differences were observed on the plants applied with CPGR and on the plants without CPGR. As observed and recorded, the plants applied with CPGR have the highest biomass of 1,413.58 (kg ha-1) while the biomass of the plants without CPGR is 1,335.13 (kg ha-1).

In the interaction of variety and CPGR, no significant differences were observed. The increase in biomass with the application of CPGR can be associated with the study of Muñoz *et al*., (20011) revealing that the augmented leaf biomass in tobacco was due to the stimulated photosynthesis and carbon fixation in plants including enhanced ribulose 1, 5 biphosphate carboxylase oxygenase activity.

Yield and Yield Components

Table 3: Number of pods per plant, seeds per pod, filled pods (%) and seed size (g) for peanut varieties grown during wet season in response to CPGR

Treatment	Number of Pods Per Plants	Seed Count Per Pod	Filled Pods (%)	Weight of 100 Seeds (G)
Variety (A)	ns	**	ns	**
1 Ilocos Red	12.45	3.00a	84.36	38.24b
2 NSIC Pn9	11.64	3.02a	86.46	35.69c
3 NSIC Pn12	13.28	2.00b	84.33	46.22a
CPGR (B)	ns	ns	ns	ns
1 With CPGR	13.12	2.68	86.26	40.44
2Without CPGR	11.79	2.67	83.84	39.66
A x B	ns	ns	**	ns
CV (a)	12.39	3.12	5.02	9.61
CV (b)	20.75	3.12	6.93	12.42

ns-not significant
**-significant at 1% level
*-significant at 5% level
CV- Co-efficient of variation
Means with the same letter within each column are not significantly different using LSD test.

No significant differences were observed on the varieties used. Variety 3 (NSIC Pn12) had the highest number of pods per plant with an average of 13.26, followed by variety 2 (NSIC Pn9) with 11.72 and the lowest is variety 1 (Ilocos Red) with an average of 11.2.

In the application of CPGR, no significant differences were observed. Numerically, plants applied with CPGR have the higher number of pods per plant produced with an average of 12.28, than plants without the application of CPGR with only 11.84 pods per plant.

The use of different rates of carrageenan on peanut varieties consistently and significantly produced the most number of pods per plant, which remarkably contributed to the enhancement of both pod and seed yield as mentioned by Aurige, *et al*., 2018.

Varietal differences were observed on their seed count per pod as shown in Table 3. NSIC Pn9 has the highest seed count per pod with an average of 3.02 followed by Ilocos Red with 3.00; and the lowest, NSIC Pn12, with 2.00 seeds per pod.

Highly significant differences were recorded in the interaction between the peanut varieties and the application of CPGR. Figure 3 shows that variety 1 (Ilocos Red) applied with CPGR recorded the highest percent of filled pods with an average of 86.34, followed by variety 3 (NSIC Pn12) with an average of 86.28, and variety 2 (NSIC Pn9) giving the lowest percent filled pods with an average of 86.17.

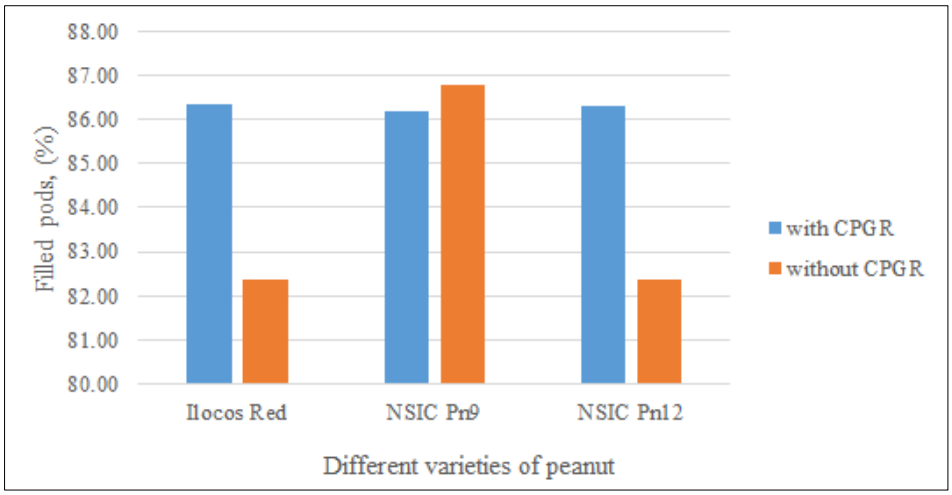

Figure 3: Interaction effects between varieties and CPGR on the filled pods per plant of peanut, WS 2018

The result of the study conforms with the findings mentioned by Aurige, *et al*., 2018, that the use of different rates of carrageenan on peanut varieties consistently and significantly produced the most number of pods per plant, which consequently contributed to the enhancement of pod, seed development, and yield in peanut.

Seed size is represented by weight of 100 seeds. Table 3 shows that significant differences were observed on the different varieties of peanut applied with CPGR. Among the three varieties used, variety 3 (NSIC Pn12) has the heaviest seed size with an average of 46.22g, followed by variety 1 (Ilocos Red) with an average of 38.24g. Variety 2 (NSIC Pn9) obtained the least with an average of 35.69g.

Table 4 shows that significant differences were observed on the different varieties of peanut applied with CPGR. Among the three varieties used, NSIC Pn12 has the highest marketable pods with an average of 97.82 %, followed by variety 2 (NSIC Pn9) with an average of 97.43%, and variety 1 (Ilocos Red) obtaining the least with an average of 94.11 %.

Table 4: Marketable pods, shelling percentage (%), and dry pod yield (t ha^{-1}) for peanut varieties grown during wet season in response to CPGR

Treatment	Marketable Pods (%)	Shelling Percentage (%)	Dry Pod Yield (T Ha^{-1})
Variety (A)	**	**	ns
1 Ilocos Red	94.11b	63.36c	1.47
2 NSIC Pn9	97.43a	67.89b	1.42
3 NSIC Pn12	97.82a	71.18a	1.45
CPGR (B)	ns	ns	ns
1 With CPGR	96.26	67.16	1.51
2 Without CPGR	96.65	67.79	1.37
A x B	ns	ns	ns
CV (a)	2.73	4.64	15.61
CV (b)	4.73	3.47	13.51

ns-not significant
**-significant at 1% level
*-significant at 5% level
CV- Co-efficient of variation
Means with the same letter within each column are not significantly different using LSD test.

Table 4 shows that NSIC Pn12 is found to be significantly higher in shelling percentage than the other peanut varieties. NSIC Pn12 was 3-7% higher than NSIC Pn9 and Ilocos Red. However, NSIC Pn9 was more than 5 shelling percentage than Ilocos Red. This indicates that NSIC Pn12 has the highest shelling percentage of 71.18% and NSIC Pn9 and Ilocos Red following with a shelling percentage of 67.89 % and 63.36% respectively.

In Abad *et al*., (2011), results of their study indicated an increase in yield of mungbean sprayed with irradiated κappa-carrageenan (KC). Likewise, Abad *et al*., (2015) reported that radiation modified κ-carrageenan increased yield of pechay (*Brassica napus* var. *chinensis*) in terms of fresh weight. When solutions of the irradiated KC and iota-carrageenan (IC) are mixed with the growth medium for rice seedlings under

hydroponics condition, the stimulation of growth was observed.

Profitability Analysis

The cost and return analysis of the study (Table 5) shows that variety 2 (NSIC Pn9) applied with CPGR recorded the highest Net Income of Php 65, 594.00 as manifested by the high production of 1.57 (t/ha-1) and with highest return than the other treatments having the highest Benefit Cost Ratio (BCR) of 1.10.

Table 5: Cost and return analysis of one hectare for three peanut varieties grown during wet season in response to CPGR

Variety	Cpgr	Treatment	Cost of Production (Php)	Production (T/Ha^{-1})	Pod Cost (Kg)	Gross Income	Net Income (Php)	Benefit Cost Ratio (Bcr)
1	1	1	59, 906.01	1.49	40.67	119500	59, 594.00	0.99
	2	1	57, 256.01	1.43	40.18	114700	57, 444.00	1.00
2	1	1	59, 906.01	1.57	41.16	125500	65, 594.00	1.10
	2	1	57, 256.01	1.27	46.65	101900	44, 644.00	0.79
3	1	1	59, 906.01	1.48	42.30	118500	58, 594.00	0.98
	2	1	57, 256.01	1.42	41.62	113500	56, 244.00	0.99

Note: Price per kilogram of dry pod yield: Php. 80.00

CONCLUSIONS AND RECOMMENDATIONS

The results of the study led to the conclusion that the application of CPGR on the different varieties of peanut gave significant differences on yield of the crop.

Generally, the plants applied with CPGR performed the best in terms of the growth and yield of the peanut varieties grown during wet season. The best variety that gives the highest yield under wet season is NSIC Pn9 applied with CPGR. The positive response of peanut on the application of CPGR as implied by the increased number of pods, caused the increase in dry pod yield. This can be contributed by the ability of CPGR to bolster plant growth development as it helps in enhancing the production of pods per plant in peanut.

As to net income and BCR, variety 2 (NSIC Pn9) applied with CPGR recorded the highest among the other varieties. While, variety 3 (NSIC Pn12) applied with CPGR recorded the lowest net income and BCR.

In view of the results of this study, it is strongly recommended to utilize variety 2 (NSIC Pn9) with CPGR during the wet season since it produces the highest yield and net profit, thereby making it more profitable for the peanut farmers. NSIC Pn9 is a good substitute for Ilocos Red variety during the wet season.

It is further suggested that studies along this line must be evaluated during the dry season cropping to come up with more conclusive result.

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