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Effect of Different Plant Hormons on Early Production of Two Commercial Pineapple Varieties in Bangladesh

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Abstract:

The study was conducted in jackfruit-pineapple based agroforestry system at BSMRAU, Gazipur from January 2012 to December 2012 to study the effect of hormone on early pineapple production and makes it year-round. The pineapple was grown in two years old jackfruit orchard. The planting materials of pineapple was slipping sucker and the age of pineapple was one year at the time of hormone application. Three hormones were tested on two pineapple varieties following two factorial RCBD with three replications. The pineapple varieties were honey queen and giant kew, While the hormones were NAA, Ethephon and CaC_2. Fruit length, fruit diameter, fruit weight, crown weight, fruit yield of fruit of both varieties were influenced by different hormones. Fruit length, fruit diameter, fruit weight, crown weight and fruit yield of giant kew were higher than honey queen irrespective of hormones application. Application of hormone had remarkable influence on flowering characters. All the hormones induced earlier flowering over control. Effect of ethephon and calcium carbide on early flowering of giant kew was faster than honey queen. In giant kew, first inflorescence appearing to last flowering was 35-60 days for ethephon application and it was 40-65 days for CaC_2. In honey queen, time span for first inflorescence appearing to last flowering was 42-65 days for ethephon while as again 50-72 days for CaC_2. On the other hand, NAA showed inverse effect i.e. response of honey queen was faster than giant kew for first inflorescence appearance although both varieties took longer time than ethephon and calcium carbide as well and duration was 50-75 and 55-84 days for honey queen and giant kew

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respectively. Fruiting was also affected due to hormones application. Among the hormones, performance of ethephon was found to be the best (95.5 % fruiting) followed by calcium carbide (81.11 %) irrespective of varieties. The poorest performance was recorded for NAA (70.0 %) over the both varieties.

Keywords: Plant hormone, Ethephon, Calcium carbide, NAA, Pineapple, Early production.

INTRODUCTION

Agroforestry is one of the suitable alternatives of land use system to enhance food production and household income for basic needs, and ensure ecological stability. lt is the sustainable integrate land use system of growing both perennial fruit trees and annual agricultural crops on the same land unit in concurrent or sequential way (Nair,1987). These traditional agroforestry systems have been contributing to the livelihood system of the rural households of Bangladesh for centuries by providing diversified products (Abedin & Quddus, 1990). Pineapple (*Ananas comusus* L.) is one of the major fruits of Bangladesh. It constitutes about 10 % of the total fruit production of the country (Hossain, 1999). However, pineapple production in Bangladesh is very low compared to that of other pineapple producing countries of the world. Shade loving nature of pineapple is already proven, yield and quality of pineapple fruits are also improved when it is grown under partial shade (Hossain, 1999). But delayed and irregular flowering and short harvesting season are the problem of pineapple production and its year-round availability in Bangladesh. From different research findings it was found that, use of growth regulator/hormone in pineapple induced early flowering and helped to harvest fruits out of the season (Uddin *et. al*.,2010). Sen (1990) reported that more than 90% plants flowered 50 days after application of ethrel or ethephon at a concentration of 25 ppm in combination with urea (2%) and $CaCO_3$ (0.04%). Saxena (1984) also reported that 100 ppm ethephon was the most effective in inducing flower. Plantifix (NAA) is also used for inducing early flowering of pineapple in Srilanka. Effect of growth regulators in inducing flower varied according to environmental condition. Early, uniform and year-round production of pineapple was possible by the application of growth regulators especially ethephon (ethrel) and calcium carbide (Bose *et al*., 1983). A vast area of Tangail, Srimongal and Gazipur is under pineapple cultivation. The farmers of these areas will be benefited economically if they can harvest pineapple fruits earlier get of the pick season. To expand the harvesting period of pineapple, the experiment was conducted to achieve the following objectives, 1. To find out suitable hormone/ growth regulators for early flowering of pineapple, 2. To select particular hormone suitable for a pineapple variety.

MATERIALS AND METHODS

The experiment was conducted from January 2012 to December 2012 in the Jackfruit-pineapple based agroforestry research field of the Department of Agroforestry and Environment, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU). The University is situated at Salna, 40 km away from capital city Dhaka.

The study site was located at the center of Madhupur Tract (24.09^0 N latitude and 90.26^0 E longitude) with a mean elevation of 8.5 m above sea level. The soil of BSMRAU research farm belongs to Salna series of Shallow Red -Brown Terrace soil type (Brammer, 1971; Shaheed, 1984) with silty clay in surface and silty clay loam in sub-surface region. The experimental soil was under Inceptisol order as per USDA soil classification. The soil texture was silty clay loam with sand 7 %, silt 47 %, and clay 36 % with pH of the soil 6.5 and CEC 25.58 me/100g soil. The experiment was conducted with two factors. Factor A: two popular pineapple varieties - Giant kew (V_1) and Honey queen (V_2) and Factor B: three types of growth regulator – Contrrol (T_0), Ethephon (T_1), Calcium carbide (CaC_2) (T_2) and Napthalene Acetic Acid (NAA) (T_3). The experiment was laid out in randomized complete block design (RCBD) with three replications. The climate of the experimental area was sub-tropical in nature, characterized by three distinct seasons. The monsoon, pre-monsoon or hot season extends from March to April and the winter season from November to February (Idris *et al.,* 1979). Pineapple plants from ground sucker were in fruiting stage. On the other hand, pineapple plants from slips were in vegetative stage which might require next one year for flowering. So, the research was conducted on those plants which were established from slips for early flowering and off-season pineapple production. The land was prepared thoroughly by ploughing and cross ploughing with power tiller followed by laddering to obtain a good tilth. All the intercultural operations irrigation, weeding, mulching etc. were done properly and timely. The experimental plots were fertilized with 12 tons cow dung and 600 kg urea, 500 kg TSP, 600 kg MP per hectare. Although India recommended 600-400-600 Kg/ha of N, P_2O_5 and K_2O for pineapple (Roy *et al.,* 1996) in Jackfruit-pineapple based agroforestry system. Data were collected on different parameters and compiled for analysis. Standard statistical procedure was used to analyze the data obtained from the experiment using "Statistix-10.0" computer software to examine the significant variation of the results due to different treatments. The treatment means were compared by DMRT at 5% level of significance (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Number of leaves plant^{-1}

Total number of leaves plant^{-1} is one of the important yields contributing characters of pineapple. Total number of leaves per plant of both pineapple varieties (Giant kew & Honey queen) varied significantly. However, higher number of leaves (25.88) were observed in giant kew while the lower (23.80) was in honey queen. This variation might be due to varietal characters. Varietal literature also proved this variation. The maximum number of leaves per plant (26.42) was recorded from ethephon application (Table 2). whereas the minimum number of leaves per plant (23.43) was recorded due to NAA application. The interaction effect of different hormones and varieties on total number of leaves per plant were found significant (Table 3). The maximum number of leaves was observed in giant kew (27.45) due to ethephon application which was identical to that of control (27.30). However, lowest number of leaves were recorded in honey queen for NAA application. The positive effect of hormone on total number of leaves in pineapple was also reported by Singh *et al.* (1989).

Leaf length (cm)

Leaf length or shape varied from variety to variety. Distinguishable leaf character was observed between honey queen and Giant kew but no significant leaf length variation was recorded. Comparatively higher leaf length (45.63 cm) was recorded in honey queen than giant kew (44.37 cm) (Table 1). In this experiment, leaf length was also influenced by the application of different hormones, but their effect was not found significant. Arithmetically the highest leaf length (46.59 cm) was recorded due to NAA application On the other hand, the lowest leaf length (43.50 cm) was obtained from control. The interaction effect of variety and hormone on leaf length of pineapple was found significant. Significantly the longest leaf (48.37 cm) was observed in honey queen for NAA application and the shortest leaf (43.00 cm) was recorded in giant kew in control, (Table 3).

Crown weight (g)

Crown weight of pineapple at maturity stage was significantly influenced by different varieties of pineapple. Higher crown weight (320.13 g) was recorded in giant kew than honey queen (296.20 g) (Table 1). Significant difference of crown weight between honey queen and giant kew might be due to their varietal character. Crown weight was also influenced by the application of different hormones, but their effect was insignificant. The highest crown weight (309.93 g) was observed due to NAA application (Table 2). However, the lowest crown weight (297.70 g) was recorded from the control. The interaction effect of variety and hormone on crown weight of pineapple were insignificant. However, the maximum crown weight (320.22 g) was found in giant kew by CaC_2 application and the lowest crown weight (281.66 g) was recorded in honey queen for CaC_2 application. The crown weight of giant kew was always higher than that of honey queen irrespective of hormone application. The crown weight of honey queen (290.00 g) was recorded from control. On the other hand, the crown weight of giant kew (305.40 g) was recorded from the treatment which received no hormone (Table 3).

Days required to first flowering (days)

No significant variation was found to Days required to first flowering between two varieties but it had significant variation due to different hormonal treatment. The Minimum 46 days were required for flowering at T_2 treatment whereas the maximum at control treatment. In the case of treatment combination, the minimum 43 days was observed in V_2T_1 treatment which is statistically significant.

Fruiting percentage (%)

No significant variation was found to Fruiting percentage between two varieties but it had significant variation due to different hormonal treatment. The Maximum fruiting was found in T1 treatment. whereas the minimum at control treatment. In the case of treatment combination, the Maximum fruiting was found in V_1T_1 (97.77 %) and V_2T_2 (93.30 %) treatment combination which are statistically significantly identical while the minimum fruiting (%) was observed in control treatment for both of the varieties.

Fruit length (cm)

A little difference of fruit length was observed between honey queen and giant kew which was not found significant. However, the higher fruit length (9.78 cm) was

recorded in giant kew (Table 1). In this experiment fruit length was not influenced significantly by the application of different hormones (NAA, CaC_2 and ethephon). Numerically, the highest fruit length (10.63 cm) was recorded due to the application of NAA followed by CaC2 (9.30 cm) (Table 2). However, the lowest fruit length (8.8 cm) was recorded from control. The interaction effect of different varieties and hormones on fruit length was statistically significant. From table 3 it can be revealed that the maximum fruit length (11.02 cm) was recorded in giant kew due to the application of NAA followed by honey queen for NAA (10.23) The lowest fruit length (08.50 cm) was recorded in honey queen for control. Effect of NAA on fruit length was always remarkable over other chemicals for both pineapple varieties.

Fruit diameter (cm)

Distinguishable fruit diameter was observed between honey queen and giant kew. However, the effect of variety on fruit diameter was not significant. Numerically the maximum fruit diameter (9.32 cm) was recorded in giant kew and minimum (9.14 cm) in for honey queen (Table 4). The highest fruit diameter (9.66 cm) was recorded for NAA application followed by CaC_2 (9.36 cm) (Table 5). However, the lowest fruit diameter (8.9 cm) was recorded from control treatment which received no hormone.The interaction effect of different varieties and hormones on fruit diameter was found significant. The maximum fruit diameter (9.80 cm) was observed in giant kew for NAA application followed by CaC_2 (9.49 cm) and in the same variety and NAA application (9.51 cm) in Honey queen (Table 6). The lowest fruit diameter (8.90 cm) was recorded both in honey queen and giant kew for control.

Table 1. Effect of variety on some yield contributing characters of pineapple

Treatments	Number of leaves plant^{-1}	Leaf length (cm)	Crown weight (g)	Fruiting (%)	Fruit length (cm)	Fruit diameter (cm)
V_1	25.88 a	44.37 b	309.79 a	76.75 a	9.78 a	9.32 a
V_2	23.80 b	45.63 a	294.65 b	76.20 a	9.22 b	9.14 b
LSD $_{(0.05)}$	0.55	0.10	10.52	2.51	0.20	0.08
CV (%)	2.56	4.26	3.98	3.75	5.49	6.02
Level of sig.	**	ns	*	**	ns	ns

V_1 = Giant kew, V_2 = Honey queen

Table 2. Effect of hormones on some yield contributing characters of pineapple

Treatments	Number of leaves plant^{-1}	Leaf length (cm)	Crown weight (g)	Fruiting (%)	Fruit length (cm)	Fruit diameter (cm)
T_0	25.65 a	43.50 c	297.70 a	69.25 b	8.80 c	8.90 c
T_1	26.42 a	44.91 b	300.32 a	95.53 a	9.26 b	9.00 c
T_2	23.85 b	44.99 b	300.94 a	81.11 b	9.30 b	9.36 b
T_3	23.43 b	46.59 a	309.93 a	70.00 b	10.63 a	9.66 a
LSD $_{(0.05)}$	0.78	0.14	14.87	3.55	0.29	0.11
CV (%)	2.56	4.26	3.98	3.75	5.49	6.02
Level of sig.	**	**	ns	*	**	**

T_0 = Contrrol, T_1 = Ethephon, T_2 = Calcium carbide (CaC_2) and T_3 = Napthalene Acetic Acid (NAA)

Table 3. Interaction effect of variety and hormone on yield contributing characters of pineapple

Treatment Combination	Number of leaves plant^{-1}	Leaf length (cm)	Crown weight (g)	Fruiting (%)	Fruit length (cm)	Fruit diameter (cm)
V_1T_0	27.30 a	43.00 f	305.40 abc	67.00 c	9.10 d	8.90 d
V_1T_1	27.45 a	44.72 d	307.65 abc	97.77 a	9.30 cd	9.10 c
V_1T_2	24.22 c	44.94 bc	320.22 a	75.55 b	9.69 c	9.49 b
V_1T_3	24.53 bc	44.80 cd	305.91 abc	66.66 c	11.02 a	9.80 a
V_2T_0	24.00 c	44.00 e	290.00 cd	71.50 bc	8.50 e	8.90 d
V_2T_1	25.40 b	45.10 b	293.00 bcd	93.30 a	9.23 d	8.91 d
V_2T_2	23.47 c	45.03 b	281.66 d	66.66 c	8.91 de	9.22 c
V_2T_3	22.33 d	48.37 a	313.94 ab	73.33 b	10.23 b	9.51 b
LSD $_{(0.05)}$	1.11	0.20	21.04	5.02	0.41	0.16
CV (%)	2.56	4.26	3.98	3.75	5.49	6.02
Level of sig.	**	*	**	**	*	**

V_1 = Giant kew, V_2 = Honey queen; T_0= Contrrol, T_1 = Ethephon, T_2 = Calcium carbide (CaC_2) and T_3 = Napthalene Acetic Acid (NAA)

Individual fruit weight (g)

Fruit weight of pineapple varied significantly from variety to variety. The maximum fruit weight (511.40 g) was found in giant kew while the minimum (460.44 g) was recorded from honey queen (Table 4). Significant difference of fruit weight between honey queen and giant kew might be due to their inherent varietal character. Fruit weight of pineapple was significantly influenced by different hormones (NAA, CaC_2 and ethephon). The maximum fruit weight (591.31 g) was recorded for NAA application (Table 5). whereas the lowest fruit weight (422.08 g) was recorded from the control. The interaction effect of different varieties and hormones on fruit weight was found significant. The maximum fruit weight (658.51 g) was found in giant kew for NAA application followed by CaC_2 (563.82 g) in the same variety (Table 6). On the other hand, the lowest fruit weight (421.05 g) was recorded in honey queen from control which was statistically identical to that of giant kew from control (423.10 g) was identical (Table 6).

Brix percentage (%)

Brix percentage of pineapple varied from variety to variety. Distinguishable brix percentage was observed between honey queen and giant kew. However, the effect of variety on brix percentage was not found significant. The maximum brix percentage (14.32 %) was recorded from giant kew while the minimum (13.58 %) was in honey queen (Table 4). Brix percentage contributes to fruit quality and is influenced by growth regulator and hormone. the brix percentage was significantly influenced by the application of different hormones (NAA, CaC_2 and ethephon). From Table 5 it can be revealed that the maximum brix percentage (16.80 %) was recorded for CaC_2 application followed by ethephon (15.45 %). The minimum brix percentage (12.16%) was recorded for NAA application. The interaction effect of different varieties and hormones on brix percentage of pineapple was found significant. It can be revealed that the maximum brix percentage (18.14 %) was recorded in honey queen for CaC_2 application. However, the brix percentage was recorded from control (12.00) and (14.20) for honey queen and giant kew respectively which received no hormone (Table 6).

Number of fruits ha^{-1}

No significant variation was found to Number of fruits ha^{-1} between two varieties but it had significant variation due to different hormonal treatment. The Maximum fruiting

was found in T_1 (26,553) treatment. whereas the minimum at control treatment. In the case of treatment combination, the Maximum fruiting was found in V_1T_1 (27,157) and V_2T_1 (25,916) treatment combination which are statistically significantly identical while the minimum fruiting (%) was observed in control treatment for both of the varieties.

Marketable yield (t ha^{-1})

Significant variation was found to marketable yield ha^{-1} between two varieties and the maximum yield (10.73 t ha^{-1}) was obtained from V_1 variety that is Giant kew on the other hand different hormonal treatment made significant variation also. The Maximum yield ha^{-1} was found in T_1 (11.63 t) and T_3 (11.34 t) treatment which are statistically identical. whereas the minimum at control treatment. In the case of treatment combination, the Maximum yield was found in V_1T_1 (12.07 t) which is statistically identical to V_2T_2 (11.87) treatment combination while the minimum fruiting (%) was observed in control treatment for both of the varieties.

Fruit ripening period (days)

Significant variation was found to fruit ripening period between two varieties and hormonal treatments. The minimum days (148 days after sowing) required for ripening the Giant kew variety and T2 treatment also showed the fruit ripening with minimum days. In the case of treatment combination, the Maximum fruiting was found in V_1T_1 (123 days after sowing) took the minimum days to ripen the fruits.

Plant Age at harvest (days)

Significant variation was found to age of the plant during harvest. It ranges from 543-590 days due to different treatment in both of the varieties.

Table 4. Effect of variety on some yield contributing characters of pineapple

Treatment	Individual fruit weight (g)	Brix percentage (%)	Number of fruits ha^{-1}	Marketable Yield (t/ha)	Ripening period (days)	Plant age at harvest (days)
V_1	511.40 a	14.32 a	21,257 a	10.73 a	148.75 b	568.75 b
V_2	460.44 b	13.58 a	21,062 a	9.65 b	152.50 a	572.50 a
LSD $_{(0.05)}$	19.27	0.87	726.61	0.74	1.88	1.88
CV (%)	4.53	7.15	3.92	8.33	6.43	5.38
Level of sig.	**	ns	**	**	*	*

V_1 = Giant kew, V_2 = Honey queen

Table 5. Effect of hormones on some yield contributing characters of pineapple

Treatment	Individual fruit weight (g)	Brix percentage (%)	Number of fruits ha^{-1}	Marketable Yield (t/ha)	Ripening period (days)	Plant age at harvest (days)
T_0	422.08 c	13.10 bc	19,167 b	8.09 c	167.50 a	587.50 a
T_1	437.73 c	13.75 b	26,536 a	11.63 a	126.67 d	546.67 d
T_2	492.56 b	16.80 a	19,629 b	9.70 b	148.33 c	568.33 c
T_3	591.31 a	12.16 c	19,305 b	11.34 a	160.00 b	580.00 b
LSD $_{(0.05)}$	27.25	1.23	1027.60	1.05	2.65	2.65
CV (%)	4.53	7.15	3.92	8.33	6.43	5.38
Level of sig.	**	*	**	*	**	**

T_0 = Contrrol, T_1 = Ethephon, T_2 = Calcium carbide (CaC_2) and T_3 = Napthalene Acetic Acid (NAA)

Table 6. Interaction effect of variety and hormone on yield contributing characters of pineapple

Treatment Combination	Individual fruit weight (g)	Brix percentage (%)	Number of fruits ha^{-1}	Marketable Yield (t/ha)	Ripening period (days)	Plant age at harvest (days)
V_1T_0	423.10 c	14.20 bc	18,611 c	7.87 b	165.00 b	585.00 b
V_1T_1	435.79 c	14.50 bc	27,157 a	11.86 a	123.33 f	543.33 f
V_1T_2	528.18 b	15.45 b	20,925 b	11.10 a	146.67 d	566.67 d
V_1T_3	658.51 a	13.14 cd	18,333 c	12.07 a	160.00 c	580.00 c
V_2T_0	421.05 c	12.00 de	19,723 bc	8.30 b	170.00 a	590.00 a
V_2T_1	439.66 c	13.00 cd	25,916 a	11.39 a	130.00 e	550.00 e
V_2T_2	456.94 c	18.14 a	18,332 c	8.30 b	150.00 d	570.00 d
V_2T_3	524.10 b	11.18 e	20,277 b	10.60 a	160.00 c	580.00 c
LSD $_{(0.05)}$	38.54	1.74	1453.21	1.48	3.76	3.76
CV (%)	4.53	7.15	3.92	8.33	6.43	5.38
Level of sig.	**	**	**	**	*	**

V_1 = Giant kew, V_2 = Honey queen; T_0= Contrrol, T_1 = Ethephon, T_2 = Calcium carbide (CaC_2) and T_3 = Napthalene Acetic Acid (NAA)

Effect hormone on flowering of pineapple

Application of hormone had remarkable influence on flowering characters of pineapple (Table 9). Application of Ethrel (Ethephon), Calcium carbide and NAA on different dates induced earlier flowering over control. Effect of ethephon and calcium carbide on early flowering of giant kew was faster than honey queen. In giant kew, 35-60 days were required from first inflorescence appearing to last flowering for ethephon application, while it was 40-65 days for CaC_2. In honey queen, from first inflorescence appearing to last flowering, time span was 42-65 days for ethephon application while it was 50-72 days for CaC_2. On the other hand, NAA showed inverse effect i.e. response of honey queen was faster (50 days) than giant kew (55 days) for first inflorescence appearance while was longer time for both the varieties due to ethephon and calcium carbide application (Table 7).

Table 7. Influence of hormone on early flowering of pineapple

Time of forcing	Hormone	Variety	Plant age at forcing (days)	1st Inflorescence appeared (DAF*)	Full Inflorescence appeared (DAF*)	1st flowering (DAF*)	Last flowering (DAF*)
January	Ethephon	V_1	420	42	57	52	65
		V_2		35	47	43	60
	Calcium carbide	V_1	420	50	65	57	72
		V_2		40	52	51	65
	NAA	V_1	420	50	64	60	75
		V_2		55	67	65	64
No forcing	control	V_1	420	60	70	69	81
		V_2		59	70	66	80
Maximum value		-		60	70	69	81
Minimum value		-		35	47	43	60
Standard deviation		-		9.14	8.57	8.85	7.89

* DAF = Days After Forcing

Summary

An effective and compatible agroforestry system can ensure maximum utilization of available resources and ultimately increase production and income. The yield of honey queen was 11.39 t/ha, 8.30 t/ha and 10.60 t/ha for ethephon, CaC_2 and NAA application, respectively. Again, the yield of giant kew for ethephon application was 11.86 t/ha for CaC_2 11.10 t/ha and NAA 12.07 t/ha. It is to be noted that yield of giant kew was always higher than honey queen irrespective of hormone application. It was revealed that ethephon performed the best for early flowering and maximum fruiting followed by

calcium carbide, while NAA showed the poorest performance. Giant kew performed better than honey queen in response to hormones. Number of fruits per hectare of honey queen and giant kew were recorded 25,916 and 27,157 respectively for ethephon application and income generated (excluding hormone and it's application cost) was TK. 7,60,680 and TK. 8,16,510 per hectare, respectively. Thus, the income increased 92.80% and 107.40% over control from honey queen and giant kew respectively. The number of fruits per hectare of honey queen and giant kew were recorded 18,332 and 20,925, respectively for CaC_2 application and income generated (excluding hormone and it's application cost) was TK. 5,34,890 and TK. 6,51,560 TK per hectare respectively and income increased by 35.60% and 65.60% over control for honey queen and giant kew respectively. On the other hand number of fruits per hectare of honey queen and giant kew were 20,277 and 18,333, respectively due to NAA application and income generated (excluding hormone and it's application cost) was TK. 5,93,210 and TK. 5,34,990 per hectare, respectively. The income increased by 50.30% and 35.90% over control from honey queen and giant kew, respectively.

CONCLUSION

An effective and compatible agroforestry system can ensure maximum utilization of available resources and ultimately increase production and income. Based on the findings of the study, the following conclusion could be drawn: Ethepon performed the best for early flowering and maximum fruiting followed by calcium carbide, while NAA showed the poorest performance. Giant kew performed better than honey queen in response to the hormone. Application of effective hormone will save 40-45 days and will increase the income of pineapple growers.

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