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Effects of $KClO_3$, KNO_3 and urea on the flowering and fruiting of mango and longan

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Abstract: An experiment was conducted to investigate the effects of different chemicals on the flowering and fruiting of nine years old mango (*Mangifera indica*) cv. Amrapali and six years old longan (*Dimocarpous longan*) at the BAU Germplasm Centre, FTIP, Bangladesh Agricultural University, Mymensingh in one fruiting season from November 2008 to July 2009. Amrapali variety of mango and Malaysian longan were taken under study. The different chemicals used were potassium chlorate ($KClO_3$) (0.93g / ft^2 canopy ground area), potassium chlorate (KNO_3) 4% and urea at 4%. The experiment was laid out in randomized complete block design (RCBD) with three replications. In mango 4% KNO_3 was considered to be the best among the three treatments in terms of earlier emergence of panicle, number of panicles $plant^{-1}$, fruit set, number of fruits retained, number of fresh fruits $plant^{-1}$ and yield. Foliar application of 4% KNO_3 produced the highest number of panicles, highest number of fruits (581.00) and yield (78.18 Kg) $plant^{-1}$. $KClO_3$ performed better than urea but the heaviest fruit (138.60 g) was obtained from urea treated plants. Though KNO_3 showed the earlier emergence of panicle compared to others but the fruits of all treatments attained maturity at the same time. In longan, soil drench application of $KClO_3$ (0.93g / ft^2 canopy ground area) was considered to be the best among the three treatments as regard to early emergence of panicle, number of panicles, fruit set, number of fruits retained, number of fresh fruits and yield $plant^{-1}$. The highest number of panicles (77.33), number of fruits (83.17) and yield (0.41Kg) $plant^{-1}$ as well as the heaviest fruit (4.97 g) were produced by the plants treated with $KClO_3$ which was followed by KNO_3 treated plants.

Key words: Mango, Longan, KClO3, KNO3, Urea

Introduction

The research regarding regulation of flowering and harvesting time, increasing yield and quality of mango by using urea, potassium nitrate and potassium chlorate is very meager or nil in Bangladesh. Although many attempts have been made around the world with different mango varieties, so far no study was found on the variety Amrapali. The improvements in crop productivity in modern agricultural systems are increasingly dependent on manipulation of the physiological activities of the crop by chemical means (Subhadrabandhu *et al.,* 1999). Earlier flowering in mango promoted by foliar spray of KNO_3, which promotes ethylene biosynthesis (Mosqueda-Vazquez and Avila-Resendiz, 1985). It has been reported from the Philippines that KNO_3 is an effective flower inducer in mango variety Carabao. About 4.5 to 8.5 month old 'Carabao' mango shoots sprayed with potassium nitrate at 10 to 40 g/liter induced off season flowering (Astudillo and Bondad, 1978). Foliar spraying of urea and KNO_3 significantly increased the flowering percentage of mango (Rajput and Singh, 1988; Barros *et al.,* 1998; Catchpoole and Bally, 1993). Development of forcing flower initiation by potassium chlorate was first developed in Taiwan. Subhadrabandhu and Yapwattanaphun (2001) reported that the application of potassium chlorate as soil drench, foliar spray and stem injection can induce flowering during the off-season flowering of longan in Thailand. Longan (*Dimocarpus longan)* under the familly Sapindaceae, is a subtropical fruit plant, well adapted to tropical climates with distinctive wet/dry periods and subtropical areas with a cool, nonfreezing fall/winter period. It is one of the minor fruits in Bangladesh. At present no sufficient documentation on longan production is available to define current situation in Bangladesh. Economically the longan is an important crop in southeast Asia. Leaves and flowers are sold in markets but are not a part of ancient traditional medicine. The leaves contain quercetin and quercitrin. The dried flowers are exported to Malaysia for medicinal purposes. The seeds are administered to counteract heavy sweating and the pulverized kernel, which contains saponin, tannin and fat, serves as a styptic. Fruit may be frozen whole in polyethylene bags or air-tight containers. In other producing countries fruits are dried and canned. This helps to popularize the fruit by extending the normally very short season. The fruit is a good source of potassium and low in calories.

Alternate bearing is an important problem both in mango and longan. Florida, Thailand, Taiwan, China and some other countries had conducted some experiments on longan to know the responses of some chemicals like $KClO_3$, KNO_3**,** Gibberellic acids, ethrel etc. The technology of using $KClO_3$, KNO_3 and urea in order to manipulate the harvesting time, increasing yield and quality of mango under Bangladesh condition are not available. Hence, it was felt necessary to study the effects of $KClO_3$, KNO_3 and urea on flowering and fruiting in helping the farmers with scientific information for prolonging the harvesting time, increased yield as well as quality attributes of mango and longan. In this aspect, the present study was, therefore, undertaken to see the effects of $KClO_3$, KNO_3 and urea on the flowering and fruiting of mango and longan.

Materials and Methods

The present study was conducted at the BAU Germplasm Centre of Fruit Tree Improvement Project (FTIP), Bangladesh Agricultural University, Mymensingh during the period from 15 November 2008 to 30 July 2009 which covered one fruiting season for mango and longan. The soil of the Germplasm Centre was silty loam which belongs to the Old Brahmaputra Flood Plain (FAO, 1971). The mango orchard was located at a medium high land, fertile, well drained and slightly acidic with Soil pH 6.5 and 6.3 up to depth of 0-15 cm and 15-30 cm, respectively. The experiment was done on 9 years old mango plants of Amrapali and 6 years old longan plants of Malaysian longan. The spacing of the plants was 5 m × 5 m. The single factor experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Two plants were considered as an individual replication. The total number of mango plants was 3 ×3 ×2 = 18 and

the total number of longan plants was 3 ×3 ×2 = 18 also. Treatments were (i) $KClO_3$ (0.93g /ft^2 canopy ground area) : The solution of $KClO_3$ was prepared by dissolving 1.67 g $KClO_3$ (Syngenta Chemical Co., Laboratory grade) into 1litre of fresh water.
(ii) KNO_3 at 4%: The solution of 4% KNO_3 was prepared by dissolving 40 g of KNO_3 into 1 litre of fresh water with 3 drops of Tween 80.
(iii) Urea at 4%: The urea solution of 4% was prepared by dissolving 40 g of urea in 1 litre of fresh water with 3 drops of Tween 80.
The data were recorded on the following parameters-date of first panicle emergence, number of panicles $plant^{-1}$, fruit set $panicle^{-1}$, number of fruits retained $panicle^{-1}$, date of harvest, number of fruits $plant^{-1}$, yield $plant^{-1}$, fruit weight, fruit length, fruit breadth. Statistical analysis was done for LSD.

Results and Discussion

In case of mango species the first emergence of panicle ranged from 19 December 2008 to 23 December 2008 (Table 1). The plants sprayed with KNO_3 solution at 4% showed the earliest emergence as compared to the latest appearance in $KClO_3$ treated plants. The KNO_3 treated plants demonstrated earlier panicle emergence compared to others. The results are in agreement with the findings of Oosthuyse (1996).In case of longan species the first emergence of panicle ranged from 13 February 2009 to 17 February 2009 (Table 2). The plants sprayed with $KClO_3$ solution showed the earliest emergence as compared to the latest appearance in KNO_3 treated plants. The results are in agreement with the findings of Oosthuyse (1996).

Table 1. Influence of $KClO_3$, KNO_3 and urea on emergence and number of panicles $plant^{-1}$ of mango (2008-2009)

Treatment	Date of first appearance of panicle	Number of panicles emerged $plant^{-1}$ at the date of							
		25/12	04/01	14/01	24/01	03/02	13/02	23/02	03/03
$KClO_3$(0.93g / ft^2 canopy ground area)	23.12.2008	7.33	59.50	154.17	192.33	229.33	265.00	268.83	270.67
KNO_3 at 4%	19.12.2008	7.00	61.67	166.67	196.17	256.33	348.33	348.67	349.50
Urea at 4%	20.12.2008	4.33	32.50	122.17	130.33	134.50	139.17	141.67	142.33
LSD (0.01)		7.43	9.57	24.78	29.75	47.86	103.55	108.28	111.46

Highly significant differences at all dates of data recording were registered in terms of number of panicles $plant^{-1}$ as influenced by the different treatments (Table 1).In mango species, KNO_3 at 4% always showed the highest number of panicles $plant^{-1}$ and it was 349.50 on 03.03.09. The urea treated plants produced the lowest number of panicles $plant^{-1}$ at all dates. In longan species, $KClO_3$ always showed the highest number of panicles $plant^{-1}$ and it was 77.83 on 27.04.09 **(**Table 2). The urea treated plants produced the lowest number of panicles $plant^{-1}$at all dates.

Table 2. Influence of $KClO_3$, KNO_3 and urea on emergence and number of panicles $plant^{-1}$ of longan (2008-2009)

Treatment	Date of first appearance of panicle	Number of panicles emerged $plant^{-1}$ at the date of							
		17/02	27/02	07/03	17/03	27/03	07/04	17/04	27/04
$KClO_3$(0.93g / ft^2 canopy ground area)	13.02.2009	4.00	15.83	35.67	55.33	69.00	75.00	77.33	77.83
KNO_3 at 4%	17.02.2009	3.67	10.50	12.83	13.33	13.83	14.67	14.83	15.00
Urea at 4%	16.02.2009	2.00	2.50	2.50	2.67	2.67	3.00	3.17	3.33
LSD (0.01)		12.72	6.76	8.88	21.41	31.38	31.70	32.98	33.26

In mango species, fruit set $panicle^{-1}$ was found highly significant due to different chemical treatments (Table 3). The highest fruit set $panicle^{-1}$ (21.67) was obtained from the treatment of KNO_3 at 4% as against the lowest (15.50) fruit set in urea treated plant. Fruit set $panicle^{-1}$ was found significant due to different chemical treatments in case of longan species (Table 4). The highest fruit set $panicle^{-1}$ (20.33) was obtained from the treatment of $KClO_3$ as against the lowest (0.17) fruit set in urea treated plant.
It was revealed from the result that the number of mango fruits retained $panicle^{-1}$ had no significant effect among the chemical treatments (Table 3). The treatment of KNO_3 at 4% always registered the highest number of fruits retentio $panicle^{-1}$ starting from 22 March 2009 upto harvest and it was recorded 1.69 at harvest, which was statistically at par to that of $KClO_3$ (1.17), whereas the urea at 4% treated plants had the lowest fruits (1.23) $panicle^{-1}$.
It was revealed from the result that the number of fruits retained $panicle^{-1}$ in longan species varied significantly among the chemical treatments (Table 4). The treatment of $KClO_3$ always registered the highest number of fruits $panicle^{-1}$ starting from 25 May 2009 upto harvest and it was recorded 1.48 at harvest, which was statistically at par to that of KNO_3 (0.11), whereas the urea at 4% treated plants had no fruits $panicle^{-1}$.Mango treated by all chemicals was harvested at the same date on 21 June, 2009

and longan treated by all treatments was also harvested at the same date on 24 July, 2009. So, chemicals had no significant effect on the earliness of maturity of the two species.

Table 3. Influence of $KClO_3$, KNO_3 and urea on fruit set and fruit retention panicle^{-1} of mango (2008-2009)

Treatment	Fruit set panicle^{-1}	Number of fruits retained panicle^{-1} at the date of						
		22/03	01/04	11/05	21/05	02/05	12/06	21/06
$KClO_3$(0.93g / ft^2 canopy ground area)	17.67	6.50	3.75	2.09	2.09	1.50	1.31	1.17
KNO_3 at 4%	21.67	9.19	4.70	2.63	2.63	1.96	1.74	1.69
Urea at 4%	15.50	5.45	2.80	2.02	2.02	1.37	1.26	1.23
LSD (0.01)	8.77	3.89	6.33	0.87	0.87	1.08	1.04	1.07

Table 4. Influence of $KClO_3$, KNO_3 and urea on fruit set and fruit retention panicle^{-1} of longan (2008-2009)

Treatment	Fruit set panicle^{-1}	Number of fruits retained panicle^{-1} at the date of						
		25/05	04/06	14/06	24/06	04/07	14/07	24/07
$KClO_3$(0.93g / ft^2 canopy ground area)	20.33	7.83	4.67	2.47	1.95	1.58	1.51	1.48
KNO_3 at 4%	1.33	0.80	0.73	0.35	0.28	0.15	0.13	0.11
Urea at 4%	0.17	0.07	0.00	0.00	0.00	0.00	0.00	0.00
LSD (0.01)	14.02	3.93	0.62	0.82	0.49	0.69	0.74	0.75

Table 5. Influence of $KClO_3$, KNO_3 and urea on fruits plant^{-1}, yield and fruit characters of mango (2008-2009)

Treatment	Number of fruits plant^{-1}	Yield (kg plant^{-1})	Fruit characters		
			Weight (g)	Length (cm)	Breadth (cm)
$KClO_3$(0.93g / ft^2 canopy ground area)	300.50	37.00	122.91	9.13	6.19
KNO_3 at 4%	581.00	78.18	134.65	9.50	6.48
Urea at 4%	168.83	23.99	138.60	9.15	6.00
LSD (0.01)	216.53	36.57	47.90	1.28	1.54

The treatments caused no significant variation in respect of fruit weight in mango species (Table 5). The heaviest fruit (138.60 g) was noted in plants treated with urea at 4% where the lightest fruit (122.91 g) was obtained from the plants treated with $KClO_3$. In longan species, the treatments caused no significant variation in respect of fruit weight (Table 6). The heaviest fruit (4.97 g) was noted in plants treated with $KClO_3$ which was followed by KNO_3 treated plants (3.92 g).

In the mango species, the number of fruits plant^{-1} was greatly influenced by the chemicals (Table 5). The treatment of KNO_3 at 4% produced maximum number of fruits plant^{-1} (581.00) and $KClO_3$ yielded the second highest fruits (300.50) plant^{-1}. The plants treated with urea at 4% exhibited the lowest number of fruits (168.83) plant^{-1}. The number of fruits plant^{-1} was greatly influenced by the chemicals in longan species also (Table 6). The treatment of $KClO_3$ produced maximum number of fruits plant^{-1} (83.17) and KNO_3 at 4% yielded the second highest fruits (1.67) plant^{-1}. The urea treated plants exhibited no fruits plant^{-1}.

In mango species, no significant difference in length of fruit was manifested due to application of $KClO_3$, KNO_3 and urea solutions (Table 5). However, KNO_3 at 4% produced the longest fruit (9.50 cm), while $KClO_3$ treated plants resulted in the shortest (9.13 cm) fruit. Significant difference in length of fruit was manifested due to application of different chemicals in longan (Table 6). $KClO_3$ produced the longest fruit (2.46 cm), which was followed by KNO_3 treated plants (1.75 cm).

In mango, no significant variation among the treatments was found in respect of fruit breadth (Table 5). However, the widest fruit (6.48 cm) was obtained from the foliar spraying of KNO_3 at 4% as against the lowest breadth of fruit in the plants treated with 4% urea (6.00 cm). Variation among the treatments was found to be significant in respect of fruit breadth in longan (Table 6). The widest fruit (2.43 cm) was obtained from the foliar spraying of $KClO_3$ which was followed by KNO_3 treated plants (1.72 cm).

In mango species the highly significant influence was observed in fruit yield among different chemical treatments (Figure 5). The highest yield of fruits was

obtained from the treatment of KNO_3 at 4% (78.18 kg plant^{-1}), which was followed by $KClO_3$ (37.00 kg plant^{-1}). The urea treated plants had the lowest yield (23.99 kg plant^{-1}). The significant influence on fruit yield was observed among different chemical treatments in longan

Table 6. Influence of $KClO_3$, KNO_3 and urea on fruits plant^{-1}, yield and fruit characters of longan (2008-2009)

Treatment	Number of fruits plant^{-1}	Yield (kg plant^{-1})	Fruit characters		
			Weight (g)	Length (cm)	Breadth (cm)
$KClO_3$(0.93g / ft^2 canopy ground area)	83.17	0.41	4.97	2.46	2.43
KNO_3 at 4%	1.67	0.01	3.92	1.75	1.72
Urea at 4%	0.00	0.00	0.00	0.00	0.00
LSD (0.01)	47.54	0.24	7.40	3.23	3.16

species (Figure 6). The highest yield of fruits was recorded from the treatment of $KClO_3$ (0.41 kg plant^{-1}), which was followed by KNO_3 (0.01 kg plant^{-1}).

Based on the results obtained from the experiment done during the period of one year, the following conclusions were made

(i) Foliar spraying of potassium nitrate caused the earliest panicle emergence and highest number of panicle emergence as well as maximum number of fruit retentions plant^{-1} in mango cv. Amrapali which will help the growers to extend the yield of mango. Potassium nitrate at 4% applied to the mango plants gave the highest yield, heaviest fruit and improved the fruit quality but it had no effect on the manipulation of harvesting time;

(ii) Soil drench application of $KClO_3$ also had the effect on number of panicles and yield plant^{-1} in mango compared to 4% urea treated plant;

(iii) Soil drench application of $KClO_3$ caused earliest panicle emergence and highest number of panicle emergence as well as maximum number of fruit retention plant^{-1} in longan species which will help the growers to extend the yield of longan. Potassium chlorate applied to the longan plants gave the highest yield, heaviest fruit and improved the fruit quality;

(iv) Foliar spraying of 4% KNO_3 also had the little effect on number of panicle and yield plant^{-1} in longan and

(v) Foliar spraying of 4% urea had little effect on the fuit set panicle^{-1} in longan but no fruit was retained panicle^{-1} upto harvest.

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