

Full Length Research Paper

Study on winter bud dormancy in Red Bayberry (*Myrica rubra*) a forest, horticulture and ornamental tree

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Received 29 December, 2010; Accepted 12 June, 2014

A study to prevent or brake bud dormancy in 3 to 4 years old *Myrica rubra* cv. 'Biji' plants under controlled green house and field conditions, was conducted using GA₃ and WPM nutrient media as fertigation and drainage. Two batches of the plant were shifted in different growth stages "dormant" and "non-dormant". Plants shifted in the month of October were in the late autumn growth stage (non-dormant), while plants shifted in the month of December were in a complete bud dormancy stage. Plants of the first batch were prevented to enter bud dormancy while in the second batch bud dormancy was broken by providing warm temperature ranging 25±3°C in the green house. Green house plants took 2-4 weeks to initiate the growth flushes as compared to 17 to 18 weeks taken for the field plants. Buds break and leaves shed in the green house were observed earlier in the plants drained with nutrients media followed by fertigation, while spraying of GA₃ delayed leaf shed and increased shoot length both in the green house and in the field. GA₃ treated plants sprouted few days earlier than that of control. Significant differences were observed in initial sprouts among the treatments of GA₃, nutrient fertigation and nutrient drainage as compared to the control plants. Similarity in days to initial sprout was observed in both the nutrient fertigation and drainage methods with a slight variation of one or two day's differences. Nutrients used as drainage showed outstanding results than fertigation.

Key words: Bud dormancy, gibberellic acid, GA₃, *Myrica rubra*, warm temperature.

INTRODUCTION

Myrica rubra with a common name of red bayberry is an important member of *Myricaceae* family used for horticultural, forestry, ornamental and medicinal purposes. This is one of the endemic species of Far East Asia grown under warm and humid climates. It is grown in China, Japan, India, Thailand, Burma and Vietnam as fruit or forest tree while in America and Europe as an

ornamental tree (Wu, 1995; Chen et al., 2004). It is also a rich source of tannin, flavonoids, polyphenols and perfumery compounds (Yang et al. 2003). Due to long lifespan, great economic value, low production costs and nitrogen fixing activity, the red bayberry is considered a good economic source for the growers (He et al., 2002; Li, 2002).

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Red bayberry is also an ideal selection for soil conservation and forest ranges. China National Forestry Bureau has selected red bayberry as one of the forest trees for soil conservation and barren land reclamation (He et al., 2004). Annual vegetative growth in *Myrica rubra* has three distinct flushes spring, summer and autumn. Spring shoots starts from late March to late June, developing from the last year spring or summer twigs. Summer flush starts from late June and ends in August, while autumn flush starts from August and ends in late October or early November depending upon the climatic condition of the region. Summer vegetative growth is the heaviest flush followed by spring and autumn.

Alternate bearing may develop if the total vegetative shoots constitute more than 60% of flowering shoots (Chen et al., 2004). The old leave abscise at the beginning of May and reach at its peak when the spring shoots stops growing; however, leaf abscission is influenced by both the growing environment and the cultivar (Chen et al., 2004).

Winter bud dormancy occurs in many fruit trees and woody perennials, and they are characterized on the basis of dormancy periods (Oukabli and Mahhou, 2007). In the dormancy period, visible growth becomes suspended but developmental changes can still occur (Saure, 1985). Some of these changes are promoted by cool temperatures and are required for breaking the dormancy. This has a great effect on the time period, amount of buds break and flowering (McPherson et al., 1997). Dormancy can be controlled by preventing plants from entering true dormancy or by hastening bud break from plants that have already entered true dormancy (Saure, 1985). The hastening bud break can be achieved by low temperature or by Gibberellic acid treatments (Criley, 1985).

Dormancy regulation in vegetative buds is necessary for plant survival, development and architecture of plants. In many cases, breaking of dormancy results in increased cell division and changes in the developmental process (David et al., 2003; Lang et al., 1987). Vegetative bud dormancy is controlled by plant hormones and the environmental signals control the production and perception of these hormones (David et al., 2003). In these, temperature plays main role in controlling bud dormancy release and subsequent growth of buds (Marc et al., 1999).

The objectives of this study was to determine whether *Myrica rubra* plants could be prevented from entering the true winter bud dormancy in the controlled green house temperature and/ or hasten the dormancy using GA₃ and nutrients media. This study will help to understand the phenomenon of dormancy in Bayberry plants which will regulate vegetative shoots throughout the year and turning the vegetative buds into floral buds. This will help to overcome the alternate bearing and could advance fruit maturation period in the plants.

MATERIALS AND METHODS

Plant material

Potted plants of *Myrica rubra* cv. 'Biji' were obtained from the Nurseries of the Horticulture Department, Zhejiang University, Hangzhou, China. These plants were approximately 65-75 cm tall and 3-4 years old. Pots were filled in with garden soil, farmyard manure, perlite and sand at 1:1:1:1 ratio by volume. Two experiments were conducted in the green house controlled temperature and relative humidity with the aim to prevent the plants from entering true bud dormancy during the chilling months and/or hasten dormancy in comparison with the plants growing under normal environmental conditions in the field. The temperature of the green house was 25±3 °C. On shifting plants to the green house, a light uniform pruning was done to remove the two-third part of the current year shoots for clear observations. All the agronomical operations were carried out as required both in the green house and in the field.

One batch of the plants was shifted to the green house in the last week of October when autumn growth flushed in *Myrica* before the onset of chill. The other batch was shifted in the first of week of December when the plants completely entered true winter bud dormancy. Average temperature and relative humidity for the months of November, December, January, February, March and April in growth chamber in comparison with the outside temperature is given in Figure 1. The weather data was recorded by a computerized meteorological observatory specially made for controlling green house environments by Priva® Intégro. The system was adjusted to record both inside and outside temperatures and relative humidity of the green house chamber after every five minutes. Plants were drenched with WPM medium diluted, 5 times once in two months and the plants were irrigated 2 days after the drenching of the nutrients. Medium pH was adjusted to 5.8. All the agronomical operations were carried out thoroughly.

One batch was shifted to the green house in the last week of November when the plants were in full dormant stage. Three treatments were applied to hasten winter bud dormancy and are given below:

- (1) Spraying of different concentrations of GA₃. Plants were sprayed with GA₃ 100, 200, 300 and 400 ppm.
 - (2) Spraying of different strength of WPM media (McCown and Lloyd, 1981) also called fertigation, which entails: (a) WPM medium diluted to ¼ strength, (b) Medium diluted to ½ strength, (c) Medium diluted to ¾ strength and (d) Full concentration of WPM medium. Medium was sprayed on the plants to wet the plants from top to bottom.
 - (3) Different concentrations of WPM media in the form of drainage called nutrient drainage was carried out: (a) WPM medium diluted to ¼ strength (b) Medium diluted to ½ strength (c) Medium diluted to ¾ strength and (d) Full concentration of WPM medium.
 - (4) None of the above method was applied to the control plants.
- There were two plants in each treatment, replicated three times. Data on days to initial sprout, leaf shedding (days counted from the day when the swollen buds were opened), number of leaves per shoots and shoot length was recorded. Analysis was done by using General Linear Model Procedure (by SAS Inc., Software package) and means were separated for significant differences using LSD test at P< 0.05.

RESULTS

Dormancy in green house versus field plants using GA₃ and nutrient media

Plants in the green house conditions did not enter the

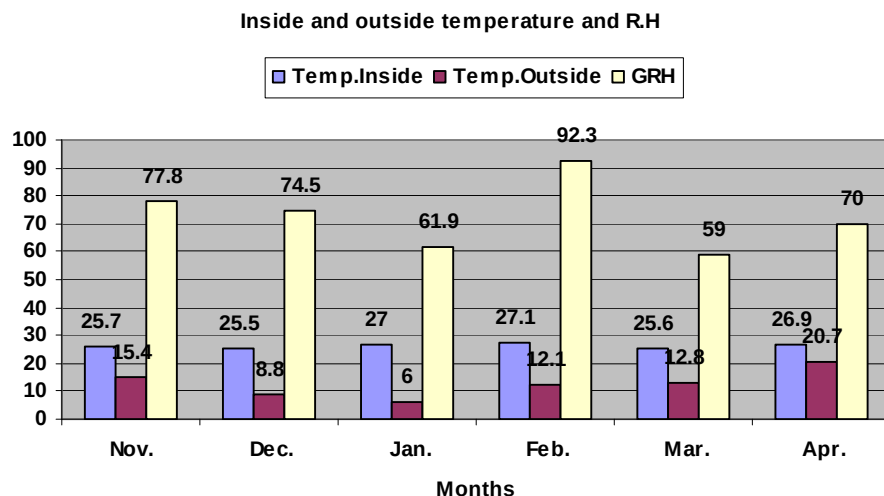


Figure 1. Temperature and relative humidity difference between inside and outside of green house.

Table 1. Effects of GA₃, nutrient fertigation and drainage on the bud dormancy of *Myrica rubra* in the green house conditions.

Treatment	Initial sprout (Days)	Leaf Shed (days)	No. of leaves	Shoot length (cm)
Control	28.67±0.577 ^a	6.33±0.578e	12.67±1.15 ^b	13.30±0.889e
GA ₃				
100	21.00±1.000 ^b	10.66±0.577d	14.00±1.00 ^b	21.37±0.611d
200	21.33±0.577 ^b	12.33±0.577 ^c	15.66±0.577 ^a	27.63±0.472 ^c
300	20.00±1.000 ^{bc}	14.33±0.578 ^b	15.66±0.578 ^a	30.77±1.550 ^b
400	18.66±0.577 ^c	17.67±0.577 ^a	16.00±1.000 ^a	34.33±1.464 ^a
Nutrient Fertigation				
¼	17.33±0.577 ^a	7.66±0.577 ^a	17.00±1.000 ^{ab}	19.20±0.916 ^c
½	17.33±0.577 ^a	7.00±1.000 ^a	18.00±1.000 ^a	20.56±0.602 ^{cb}
¾	17.00±1.000 ^a	7.33±0.578 ^a	16.33±0.577 ^b	21.86±0.378 ^b
Full conc.	15.66±0.577 ^b	7.33±1.154 ^a	17.30±0.577 ^{ab}	24.20±0.900 ^a
Nutrient Drainage				
¼	15.66±0.577 ^a	8.33±0.577 ^a	16.33±0.577 ^c	19.60±0.360 ^b
½	16.33±0.577 ^a	7.34±0.578 ^{ab}	16.66±1.527 ^c	20.20±1.900 ^b
¾	16.33±0.577 ^a	6.67±1.154 ^b	20.00±1.000 ^b	22.80±0.700 ^a
Full conc.	15.66±0.577 ^a	7.66±0.576 ^{ab}	22.330±0.578 ^a	23.93±0.305 ^a

Values are means ± standard deviation. Values within a column followed by the same letter are not significantly different at 5% level of probability using LSD test.

winter bud dormancy, Table 1. Plants neither treated with GA₃ nor fertilized though exhibited delay in the emergence of new sprouts, did not undergo the dormancy phase. Nutrients supplied in form of drainage and fertigation advanced the initial sprout followed by GA₃ treatments. Initial sprout in plants drained with all four treatments of nutrient concentrations was found non-significant; however they sprouted 13 days earlier than control plants. Significant differences in initial sprout were observed among the treatments of GA₃. Maximum

numbers of days (21.33±0.577) were taken to initial bud sprout by 200 ppm of GA₃ as compared to the minimum (18.66± 0.577) of 400ppm. Leaf shed days were counted after the first bud sprout. A significant difference was found among differences in days taken to leaf shed. Minimum days (6.33) to leaf shed were taken by control.

Comparing the three methods, plants treated with nutrient drainage shed the leaves earlier in all the treatments followed by nutrient fertigation and GA₃ respectively. Maximum days (17. 67) to leaf shed in the

Table 2. Effects of GA₃, nutrient fertigation and drainage on the release of bud dormancy of *Myrica rubra* in the field conditions.

Treatment	Initial sprout (Days)	Leaf Shed (days)	No. of leaves	Shoot length (cm)
Control	127.00±1.000 ^a	12.67±1.154 ^d	19.33±1.154 ^c	16.77±0.251 ^e
GA ₃				
100	118.67±0.0578 ^b	14.00±1.000 ^c ^d	22.67±0.578 ^{ab}	22.94±0.513 ^d
200	116.33±0.577 ^c	15.76±0.578 ^c	22.00±1.000 ^b	25.70±0.360 ^c
300	116.34±0.578 ^c	28.67±1.527 ^b	23.67±0.577 ^a	30.78±1.569 ^b
400	115.33±0.577 ^c	33.34±1.527 ^a	23.00±1.000 ^{ab}	34.40±1.200 ^a
Nutrient Fertigation				
¼	125.33±0.578 ^a	11.00±1.000 ^b	20.00±1.000 ^b	21.37±0.814 ^d
½	124.00±1.000 ^a	12.00±1.000 ^{ab}	21.34±1.154 ^b	24.80±0.200 ^c
¾	124.27±0.577 ^a	12.67±1.527 ^{ab}	23.67±0.577 ^a	27.06±0.378 ^b
Full Conc.	123.34±0.573 ^a	14.00±1.000 ^a	24.33±0.578 ^a	29.67±0.321 ^a
Nutrient Drainage				
¼	125.34±0.577 ^a	11.3±1.527 ^a	23.67±1.527 ^b	24.90±0.900 ^a
½	123.00±1.000 ^b	11.67±1.527 ^a	24.34±1.527 ^{ab}	27.56±0.802 ^b
¾	123.00±1.730 ^b	11.67±2.081 ^a	25.67±1.154 ^{ab}	27.90±0.964 ^b
Full Conc.	123.00±1.000 ^b	13.00±1.000 ^a	26.33±0.577 ^a	30.27±0.737 ^c

Values are means ± standard deviation. Values within a column followed by the same letter are not significantly different at 5% level of probability using LSD test.

green house conditions were taken by 400 ppm treatment. Data on number of leaves were recorded after two months. Maximum numbers of leaves were found when plants were drained with full concentration of nutrients followed by ¾ nutrient drainage as compared to the maximum (12.67) in control. Shoot length as observed had maximum of 34.33 cm in the plants treated with GA₃ 400 ppm followed by 30.77 and 27.63 cm in 300 and 200 ppm of GA₃ respectively as compared to the minimum (13.30) of control.

In the field conditions, all plants that were either treated or untreated entered the true winter bud dormancy due to the unfavorable environmental conditions. Different methods to break dormancy did not advance the process of dormancy. However, GA₃ treated plants in general sprouted few days earlier than that of control. Significant differences in initial sprout were observed among the treatments of GA₃, nutrient fertigation and nutrient drainage as compared to the control plants (Table 2). Maximum numbers of days (118.67±0.0578) were taken to initial bud sprout by 100 ppm of GA₃ as compared to the minimum (115.33±0.577) of 400 ppm. Similarity in days taken to initial sprout was observed in both the nutrient fertigation and drainage methods with a slight variation of one day difference.

Days to leaf shed were counted after the first bud sprout. A significant difference was found among the differences in days taken to leaf shed. Maximum days (33.34±1.527) to leaf shed were taken by the plants treated with 400 ppm of GA₃ as compared to 12.67±1.154 in the untreated plants. Only with a difference of one or

two days, all plants treated with nutrient fertigation and drainage took the same time to leaf shed. Maximum days (17.67) to leaf shed in the green house conditions were taken by 400 ppm GA₃ treatment. Data on number of leaves were recorded after two months.

On the annual shoot flush least number of leaves (19.33±1.154) were observed in control plants as compared to the maximum (26.33±0.577) in plants drained with full strength of the nutrient media. Shoot length was accelerated by the GA₃ treatments. Maximum shoot length (34.40±1.200 cm) was noted for the plants sprayed with 400 ppm of GA₃ in comparison with (16.77±0.251) of control plants.

Breaking and/or hastening dormancy

Plants shifted in the last week of October, were at the last stages of the autumn growth flushes before entering the true winter bud dormancy while those shifted in the first week of December were completely dormant. A Batch of plants shifted on October 25 did not undergo the true bud dormancy as the normal growth flushes continued even in the dormant periods by the plants in the normal field conditions. Dormancy in the plants shifted in the first week of December was broken in the green house conditions. The green house temperature played a vital role in breaking the bud dormancy. A slight difference in data on different parameters was observed as shown in Table. 3. Both the dormant and non-dormant plants showed similar trends of growth in the controlled green

Table 3. Response of *Myrica rubra* plants to the green house conditions shifted on different dates to prevent the plants to enter or accelerate winter bud dormancy.

Plant shifted on	Initial sprout (Days)	Leaf Shed (days)	No. of leaves	Shoot length (cm)
October 25, 2003	28.66± 0.577	6.33± 0.577	13.30± 0.888	12.67± 1.154
December 1, 2003	29.66± 2.51	6.67± 1.527	14.66± 1.527	14.40± 0.953

Values are means ± standard deviation. Data was collected after two months in the controlled green house conditions with an average monthly temperature of 25±3°C.

house conditions, however, improvement in the growth was observed in the parameters of the dormant plants.

DISCUSSION

It was observed that all plants in the field conditions either treated or untreated entered the true winter bud dormancy due to the unfavorable environmental conditions. On the contrary, plants either treated or untreated in the warm temperature of green house were prevented to enter bud dormancy. Green house plants took 2-4 weeks to initiate the growth flushes as compared to 17-18 weeks for the field plants. It means that due to the harsh weather conditions especially temperature the plant buds were put in to ecodormancy to temporarily terminate the growth. As the outside unfavorable conditions prevails for longer periods, *Myrica rubra* plants entered into endodormancy where signals are being transmitted to the plants to put the buds in the state of endodormancy to protect the vegetative buds by ensuring that meristems will not resume growth until the stable return of permissive conditions.

Warm temperature of the green house (25±3 °C) played a significant role in either breaking or preventing the plants from entering bud dormancy. Olavi et al. (2003) reported that exposing *Betulla* species to different temperature regimes and light conditions, the warm temperature of 21 °C significantly delayed the induction of dormancy. Temperature appears to be the main factor controlling the changes in the intrinsic growth capacity of both, floral and vegetative endodormant buds (Leite et al., 2004). Temperature plays a significant role in the induction and breaking of endodormancy (David et al., 2003). Mowat (1995) maintained the plant shoots of persimmon in the constant temperature of 23 °C, the optimum root temperature for both dormancy release and the proportion of budburst was 13°C.

The results of this study showed that plants neither treated with GA₃ nor fertilized though exhibited delay in the emergence of new sprouts, did not undergo the dormancy phase. In contrast to the field experiment, GA₃ and nutrient media application was not effective to break or hasten dormancy. Similar results where GA₃ did not retard the time of initiation of the shoots in the field conditions were reported by Roberto and Thomas (1998).

With the application of nutrient media, earlier and vigorous growth was observed in both the field and green house conditions. This may be due to the accumulation/or absorption of nutrients by plants during winter and their subsequent use in the bud break period. Accumulations of nutrients in perennial plants occur when resources supply exceeds demand (nutrient used by the plant functions), thus incurring no cost to growth. Richard et al. (1998) reported that Pistachio plants adequately fertilized, accumulated storage substances as reserve nutrients. These nutrients were allocated to reproductive and vegetative growth on resumption of the plant growth after dormant state.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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