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Effects of Different Planting Dates on Growth and Yield of Kalmegh

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Abstract
Field experiment was conducted at the Farm of Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand, during, March to November, 2016 to assess to the performance of different local kalmegh cultivars under different planting dates. Three local kalmegh cultivars (Prachinburi, Nakhon Prathom and Pitsanulok 5-4) were sown on five different planting dates (such as 1st of March, April, May, June and July, respectively) in a randomized complete block design with split plot arrangement with three replications. The results were showed that the best Prachinburi local cultivar was the highest for plant growth and dry matter yield. The planting dates shown significant effect on growth and yield that decreased with early in planting dates and the highest values were obtained when cultivars planted on 1st June. However, Prachinburi local cultivar gave the highest leaf and seed dry weight yield and the most suitable planting period was on 1st June.

Keywords: Planting date, Growth, Yield, Kalmegh

Introduction

Kalmegh, *Andrographis paniculata* (King of bitters / Hempedu Bumi) is an important herb of Acanthaceae family used to cure many ailments and diseases (Kumar *et al.,* 2004). Every part of plant has therapeutic value. Especially leaves (fresh and dry) of *A. paniculata* are extensively used in Asian traditional medicines and in various herbal combination (Srivastava *et al.,* 2002).

Presently, the total production of kalmegh was rather low yield due to poor management practices (Krishna *et al.,* 2014). For successful production of

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crop many factors, suchas, quality seed, weed control, proper fertilizer, irrigation, method of sowing, optimum sowing time, seed rate and time of harvest are indispensable (Ozturk *et al.,* 2017). Among various factors responsible for low yield of kalmegh in Thailand sowing time and varietal selection are of primary importance. Kalmegh is sown in routing season and it has list own definite requirements for rainfall, temperature and light for emergence, growth and flowering. Too early sowing produces weak plants with poor recto system as the rainfall is minimum and the temperature is above optimum. Water deficit and temperature above optimum to irregular germination and the embryo frequently dies. Late planting results in poor branch, filleting and crop growth generally slow because of low temperature. Optimum planting time range of different cultivars varies regions depending on growing conditions of a specified tract that could be assessed by planting them at different times (Sona *et al.,* 2015). Two factors limit kalmegh productivity because every crop cultivars has its own requirement for particular environmental conditions for maximum growth, which could be facilitated by proper sowing date. Thus, the objective of this study was to determine the growth, yield and andrographolide of different kalmegh cultivars against five planting dates in Bangkok, Thailand.

Materials and methods

Study area and experimental produce

The experiment to evaluate effect of different plant dates on growth and yield of three kalmegh cultivars was carried out at Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand during March to November, 2016.

The experiment comprised three local kalmegh cultivars (Pitsanulok 5-4, Prachinburi and Nakhon Prathom) and five planting dates were March 1, April 1, May 1, June 1 and July 1 and it was arranged in a randomized complete block design in split plot arrangements with three replications. Local kalmegh cultivars were laid out in main plots and the different planting dates corresponded to sub plots. Seeds were sown by hand, sowing two seeds per pot. After emergence one plant per pot was maintained. Throughout the plant life cycle, weeds were kept under control by hand weeding. The experiment pots were manured with chicken manure @ 2 t ha^{-1} and chemical fertilizers were applied at 80 kg N, 20 kg P and 27 kg K per hectare. Plants were irrigated as necessary. At harvest, two plants were selected randomly for recording necessary agronomic data on i) plant height, ii) stem dry weight, iii) number of branch per plant, iv) leaf dry weight, v) number of capsule per plant, vi) seed dry weight yield, vii) leaf dry weight yield. For phytochemical analysis,

andrographolide was determined in the dry matter of aerial parts using high performance liquid, chromatography (HPLC).

Statistical analyses

The data were analyzed statistically and means were tested by least significant difference (LSD) test ($p < 0.05$).

Results and Discussion

Plant height

The data in Table 1 showed that the differences for plant height of the cultivars under evaluation were statistically different. The highest plant height was obtained from the Prachinburi local cultivar (55.18 cm), while the minimum was produced by the Pitsanulok 5-4 local cultivar (32.47 cm). Plant height was also significantly affected by the different planting dates (Table 1). The highest plant height was observed in the plant planted on the 1st of June (58.70 cm) and the lowest plant height was recorded in the case of the plant planted at 1st of March (28.19 cm).

Stem dry weight

Local kalmegh cultivars under evaluation differed significantly from each other for stem dry weight in Table 1. The highest value of stem dry weight was obtained from the Prachinburi local cultivar (6.76 g plant^{-1}). The lowest stem dry weight was recorded the Pitsanulok 5-4 local cultivar (2.88 g plant^{-1}). The planting dates significantly affected the stem dry weight. The plant planted on 1st June produced significantly more stem dry weight (8.70 g plant^{-1}) while significantly minimum stem dry weight (0.66 g plant^{-1}) was obtained when plant was planted on March 1.

Number of branch per plant

The data on number of branch per plant disclosed that both the planting dates and local cultivars affected the number of branch per plant significantly in Table 1. It was shown that the maximum number of branch per plant (24.00) was obtained in Prachinburi local cultivar followed by Nakhon Prathom local cultivar (20.80) while the minimum of branch per plant was produced by Pitsanulok 5-4 local cultivar (16.20). The data indicated that planting times significantly affected number of branch per plant. Significantly highest number of branch per plant (28.33) was recorded when plant was planted on 1st June

which was significantly at par with 1st March planting against the minimum number of branch per plant (14.16).

Leaf dry weight

The data in Table 1 showed that the differences for leaf dry weight of the three local cultivars under evaluation were statistically different. Among the local cultivars, Prachinburi gave the maximum leaf dry weight (2.63 g plant^{-1}) significantly different from the other two local cultivars. The Pitsanulok 5-4 local cultivar produced the minimum leaf dry weight (1.37 g plant^{-1}). Data regarding leaf dry weight disclosed that planting dates affected leaf dry weight. The plant planted on 1st June produced the highest leaf dry weight (2.88 g plant^{-1}) whereas the lowest leaf dry weight (1.22 g plant^{-1}) was obtained when plant was planted on 1st March.

Table 1 Plant height, stem dry weight, number of branch per plant and leaf dry weight of three local kalmegh cultivars as affected by different planting dates.

Treatments	Plant height (cm)	Stem DW (g plant^{-1})	Number of branches per plant (branches)	Leaf DW (g plant^{-1})
Local cultivars				
Prachinburi	55.18	6.76	24.00	2.63
Nakhon Prathom	43.44	4.32	20.80	2.21
Pitsanulok 5-4	32.47	2.88	16.20	1.37
Planting dates				
1st March	28.19	0.66	14.16	1.22
1st April	36.33	3.09	17.00	1.65
1st May	43.92	4.85	19.66	2.14
1st June	58.70	8.70	28.33	2.88
1st July	51.35	5.96	22.50	2.44
Mean	43.70	4.65	20.33	2.07
LSD (0.05) (Local cultivars)	11.92	2.38	2.10	0.77
LSD (0.05) (Planting dates)	3.80	0.66	2.05	0.27
LSD (0.05) (Local cultivars x Planting dates)	ns	ns	ns	ns
C.V. (%) (Local cultivars)	14.17	26.58	14.70	19.39
C.V. (%) (Planting dates)	6.92	11.39	8.03	10.55

DW = dry weight; ns = no significant at the 0.05 probability level.

Number of capsule per plant

The data on number of capsule per plant in Table 2 revealed that among three local cultivars, Prachinburi cultivar produced significantly more number of capsule per plant (68.90) followed by Nakhon Prathom (60.90) and Pitsanulok 5-4 cultivars (28.80), respectively. Planting dates significantly affected number of capsule per plant. Significantly maximum number of capsule per plant (116.0) was recorded when plant was planted on 1st June while significantly minimum number of capsule per plant (17.28) was obtained when plant was planted on 1st March.

Table 2 Number of capsule per plant, seed and leaf dry weight yield and andrographolide content of three local kalmegh cultivars as affected by different planting dates.

Treatments	Number of capsule per plant (capsules)	Seed DW yield (g m^{-2})	Leaf DW yield (g m^{-2})	Andrographolide content (%)
Local cultivars				
Prachinburi	68.90	23.09	37.19	2.79
Nakhon Prathom	60.90	19.98	31.30	2.29
Pitsanulok 5-4	22.80	11.98	19.37	2.09
Planting dates				
1st March	17.28	17.02	17.28	1.96
1st April	25.67	17.56	23.43	2.38
1st May	41.17	18.12	30.31	2.43
1st June	116.00	19.99	40.80	2.65
1st July	66.17	19.07	34.63	2.53
Mean	50.86	18.35	29.29	2.39
LSD (0.05) (Local cultivars)	15.87	3.61	10.92	0.35
LSD (0.05) (Planting dates)	9.72	1.08	3.88	0.21
LSD (0.05) (Local cultivars x Planting dates)	ns	ns	ns	ns
C.V. (%) (Local cultivars)	16.22	10.24	19.39	7.63
C.V. (%) (Planting dates)	15.20	4.72	10.55	7.03

DW = dry weight; ns = no significant at the 0.05 probability level.

Seed dry weight yield

Seed dry weight yield was significantly affected by various cultivars (Table 2). The cultivar Prachinburi produced significantly maximum seed dry

weight yield (23.09 g m^{-2}) followed by Nakhon Prathom (19.98 g m^{-2}) and Pitsanulok 5-4 (11.98 g m^{-2}). The planting dates affected significantly the seed dry weight yield. Significantly maximum seed dry weight yield (19.99 g $plant^{-1}$) was obtained when plant was planted on 1st June with minimum seed dry weight yield (17.02 g $plant^{-1}$) in case of early planting such as 1st March.

Leaf dry weight yield

The data on leaf dry weight yield revealed that both cultivars and planting dates affected leaf dry weight yield in Table 2. Among three local cultivars, Prachinburi cultivar produced maximum leaf dry weight yield (37.19 g m^{-2}) which was statistically at par with Nakhon Prathom (31.30 g m^{-2}) and Pitsanulok 5-4 cultivars (19.37 g m^{-2}). The data regarding leaf dry weight yield shown that planting dates affected leaf dry weight yield significantly. Significantly highest leaf dry weight yield (40.80 g m^{-2}) was obtained when plant was planted 1st June against the minimum leaf dry weight yield (17.28 g m^{-2}) in case of 1st March planting.

Andrographolide content (%)

Data concerning andrographolide content in Table 2. The data indicated that cultivar Prachinburi produced the highest andrographolide content (2.79 %) followed by Nakhon Prathom (2.29 %) and Pitsanulok 5-4 cultivars (2.09 %), respectively. With regard to the impact of planting times, significantly maximum andrographolide content (2.65 %) was obtained when plant was planted on 1st June with minimum andrographolide content (1.96 %) in case of 1st March planting.

Among three local kalmegh cultivars, the cultivar Prachinburi recorded the highest growth and dry weight yield followed by Nakhon Prathom and Phisanulok 5-4, respectively. Sandeep *et al.* (2009) reported that genotypes have significantly different effect on plant growth, stem and leaf dry weight and dry weight yield. Similar results were also reported by Liphan and Detpiratmongkol (2017).

For different planting dates, the results indicated that plant height, stem dry weight, number of branch per plant, leaf dry weight, number of capsule per plant, seed dry weight yield and leaf dry weight yield of those planted late were significantly highest than those planted early (Table 1, 2 and 3). The significant difference in the aforementioned vegetative parameters could be explained by availability of adequate moisture which enabled root to absorb enough nutrient for plant growth. This observation is in line with the report of Pandey *et al.* (1984); Shivaramu and Shivashamkar (1994). According to them, adequate

moisture aids nutrient absorption to result in good growth response (Lawal *et al.*, 2011).

Singh and Dhingra (2003) also conducted a study in which growth and yield of kalmegh were varying significantly with varying date of sowing and planting geometry. Himabindu (2013) noted that among different planting treatments, late planting date gave maximum values for plant height, number of branches per plant, number of leaves per plant, leaf area, LAI, fresh and dry herb weight which were significantly superior over other early planting treatments. Dry herbage and andrographolide yield were also significantly influence due to different planting treatment at harvest. Kalmegh planted on 1st. August also recorded maximum values for herbage and andrographolide yield at harvest. Conversely, Krishna et al. (2014) reported that on 15 May of sowing with 40x25 cm planting geometry in kalmegh was the most ideal to get maximum growth and dried herb yield. However, the maximum growth and yield of kalmegh in these study were obtained from the crop sown on 1st June.

Conclusion

From the present experiment it is clear that growth and yield of kalmegh largely depend upon the cultivars and planting dates. Among the three kalmegh cultivars, Prachinburi cultivar was the best growth and yielding. In case of planting dates, late planting date (1st June) had obtained the maximum growth, seed yield and leaf dry weight yield. It seems that cultivation of Prachinburi and 1st June planting date is suitable for this region (in Bangkok, Thailand).

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