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KNO_3 Application Affect Growth and Production of *Amorphophallus muelleri* Blume

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ABSTRACT

Application of KNO_3 has been assumed able to increase productivity of Amorphophallus muelleri Blume. The purpose of this study was to clarify the effects of KNO_3 solution on the productivity A. muelleri. One-year-seed corms of 100-125 g were planted in plastic pot placed under shading net with light intensity reduced by 50% during rainy season (September 2010 to April 2011) in Bogor, Indonesia. Five levels of KNO_3, i.e., 0, 2, 4, 6 and 8% (m/v) were applied through foliar and soil sprays twice a month started at 12 weeks after planting. Results showed that application of KNO_3 significantly prolong vegetative period and increased number of leaves. KNO_3 at level 4% was optimum when applied through foliar application. Application of 4% KNO_3 through foliar spray significantly enhanced larger plant growth than similar concentration applied through soil. This result suggested that the effectiveness of fertilizer through foliar application by using 4% KNO_3 might be increased if leaf browning could be restricted. Browning was more prominent in old leaves than the young ones, thus, further observation for determining appropriate time of application is important.

Keywords: Foliar application, Indonesian konjac, potassium nitrate, vegetative growth

ABSTRAK

Pemberian larutan KNO_3 diduga dapat meningkatkan produktivitas tanaman iles-iles (Amorphophallus muelleri Blume). Penelitian bertujuan mempelajari pengaruh pemberian larutan KNO_3 terhadap produktivitas A. muelleri. Umbi utuh umur satu tahun dengan bobot 100-125 g ditanam dalam polibag yang ditempatkan di bawah naungan paranet 50% pada musim hujan (September 2010-April 2011) di Bogor, Indonesia. Lima taraf larutan KNO_3 yaitu 0, 2, 4, 6 dan 8% (b/v) diberikan melalui daun dan melalui tanah. Larutan diberikan 2 kali sebulan mulai 12 minggu setelah tanam (MST). Hasil menunjukkan bahwa pemberian KNO_3 nyata mempengaruhi pertumbuhan tanaman, khususnya meningkatkan jumlah daun dan memperpanjang masa vegetatif. Pemberian KNO_3 pada taraf 4% memberikan pengaruh tertinggi jika diberikan melalui daun. Pemberian KNO_3 taraf 4% memberikan pertumbuhan yang lebih tinggi jika diberikan melalui daun dibandingkan melalui tanah. Secara umum, tidak ada pengaruh nyata pada pertumbuhan tanaman akibat pemberian dosis KNO_3 yang diberikan melalui tanah. Penelitian berimplikasi bahwa pemberian pupuk KNO_3 melalui daun pada taraf 4% dapat ditingkatkan efektivitasnya jika kerusakan pada anak daun dapat diminimalkan. Kerusakan daun cenderung meningkat pada daun tua, oleh karena itu, studi lanjut perlu dilakukan terkait waktu aplikasi yang tepat.

Kata kunci: iles-iles, kalium nitrat, pupuk daun, pertumbuhan vegetatif

INTRODUCTION

Indonesian konjac or iles-iles (*Amorphophallus muelleri* Blume syn. *Amorphophallus oncophyllus*) is currently a new export commodity to China and Japan. Annually, about 300 ton dried-corms are exported. The *A. muelleri* is native to Indonesia (Sugiyama and Santosa, 2008) and its corm contains glucomannan ca. 72% on a dry weight basis (Zhang *et al*., 2010). Glucomannan is widely used in beverages and food industries, as well as medical purposes (Fang and Wu, 2004; Sugiyama and Santosa, 2008), paper making, textile and crude oil industry (Nishinari, 2000) and ethanol production (Kusmiyati, 2010).

In Indonesia, the corms were mainly collected from wild plants in the forest in Java, Sulawesi and Flores islands. Recently, *A. muelleri* has been introduced to forest timber companies to reduce the illegal logging and increase villager income (Santosa *et al*., 2003; Sugiyama and Santosa, 2008). *A. muelleri* becomes important crops in intercropping system because tolerant to shading (Santosa *et al*., 2006; Sugiyama and Santosa, 2008), adaptive with low fertilizers and pesticides inputs, and low investment (Santosa *et al*., 2003).

In agroforestry in East Java, productivity of *A. muelleri* was 6-10 ton fresh tuber ha^{-1} $year^{-1}$, although it was estimated that potential yield is 40 tons ha^{-1} $year^{1}$ (Santosa *et al*., 2003; Sugiyama and Santosa, 2008). The low productivity might be due to low input of chemical fertilizers and pesticides

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(Bhagavan *et al*., 2008; Zhang *et al*., 2010). Sugiyama and Santosa (2008) and Santosa *et al*. (2011) recommend application of 10 tons manure, 50 kg N, 60 kg P_2O_5 and 100 kg K_2O ha^{-1} for *Amorphophallus* growing.

In order to increase productivity in agroforestry, some farmers have applied fertilizers, mainly nitrogen. They usually spread nitrogen fertilizer (urea®) in the field one to two times during growing season, because soil application was restricted by dense planting distance (Santosa *et al*., 2003). However, many farmers reported that leaves became damage due to some urea® granules stick on leaves that it caused desiccation. Therefore, to avoid leaves damage some farmers modified urea® application by using foliar spraying (Sugiyama and Santosa, 2008). However, the effectiveness of fertilizer application through foliar spray had not been clarified yet.

Side-dressing of NK fertilizers application on *A. muelleri* had revealed inconsistent results (Sumarwoto and Widodo, 2008; Santosa *et al*., 2011), therefore, Santosa *et al*. (2011) has concluded that root might have low ability to utilize nutrients, mainly potassium. Thus, foliar application of potassium may correct deficiency. KNO_3 was used because it was the most efficacious form of K for foliar application (Howard *et al*., 1998) and able to control disease (Bhuiyan *et al*., 2007). In our preliminary study, foliar spraying 2 to 4% KNO_3 solutions increased growth of seedling. Bhagavan *et al*. (2008) reported that foliar application of KNO_3 at rate 2% (m/v) on *A. paeoniifolius* increased tuber weight and yield, but did not affected morphological characters of plant. Thus, objective of this experiment was to clarify the effect of KNO_3 application on growth of *A. muelleri*.

MATERIALS AND METHODS

Experiment was conducted at Leuwikopo Experimental Farm IPB, Darmaga (260 m above sea level) using soil of Latosol Darmaga (pH 5.2) from September 26, 2010 to April 12, 2011. The soil had a low amount of total N (0.12% by Kjeldahl method), very low available phosphorus (5.9 ppm of Bray I method) and a low amount of exchangeable potassium (0.1 ppm). Virgin soil was composed of sand: silt:clay as 13.13%: 22.06%: 64.79%. Temperature during experiment was 25.6 ^oC on average with relative humidity 85 to 88%.

Pot experiment was carried out using randomized complete block design (RCBD) with two factors, i.e., KNO_3 level and mode of application. Commercial KNO_3 fertilizer that contained 15% nitrogen, 14% K_2O, 18% Na, and 0.05% B was used. Treatments consisted of five levels of KNO_3, i.e., 0, 2, 4, 6 and 8% that applied onto two separate blocks trough foliar spray or soil application with three replicates. In each replication, 5 plants were observed. Pots were arranged in a triangle distance 60 cm x 60 cm x 60 cm. The plants were grown under the shade from planting until harvest. Light intensity was maintained (50% light intensity of full sunshine) by spreading black net at height 1.7 m.

Two weeks prior to planting, a 10 kg virgin soil was mixed with 1 kg of goat manure in a polyethylene bag (50 cm x 50 cm). A one-year-old corm which was collected from seedlings in June 2010 was planted at a depth of 5 cm below soil surface on September 26, 2010. Seed corms of 21.3±3.7 g with diameter 3.7±0.4 cm were planted. At planting, seed corms had sprouted with a main bud being 1 cm high. Basal fertilizer was applied 4 weeks after planting (WAP) at the rates of 2.0 g N, 3.0 g P_2O_5 and 2.0 g K_2O per plant, additional 2.0 g N per plant was applied at 8 WAP followed recommendation of Sugiyama and Santosa (2008). At planting, 2 g of pesticide (Carbofuran 3%) was applied per plant.

KNO_3 treatment was started at 12 WAP with interval 2 weeks until most plants entered dormancy. Control plant received only water not KNO_3. For KNO_3 treatments, KNO_3 solutions at concentration of 2, 4, 6 and 8% (m/v) were applied at the rate of 30 mL $plant^{-1}$ (850 L ha^{-1}) for either foliar or soil spraying. Watering was applied every day if there is rainfall less than 20 mm day^{-1}. Weeding was carried out twice a month. To control pest and diseases, Carbofuran 3%, diazinon 60% and Mancozeb 80% were applied every month.

Plant growth, i.e., number of leaves, leaf size and time to dormancy was observed. Petiole height was measured from 3 cm above soil level to branch of tripartite rachis. Leaf lifespan was calculated from the period from leaf emergence (one cm above soil level) until senescence. Leaf was numbered based on time of emergence, thus, the oldest leaf being number one. Daughter corm size and weight were measured after dormancy. Destructive sampling was carried out at 8, 16, and 24 WAP with three plants per replication. Harvest was carried out on April 12, 2011. Dormancy was determined by the senescence of the last leaf. Dry matter content was measured by oven-drying of peeled corm at 60 °C for 6 days. Statistical analysis and mean separation were conducted using ANOVA and Least Significant Different Test (LSD), respectively. In order to fit with statistical procedures, data with covariance larger than 30% were normalized using root of data plus 0.5. Data interaction was presented if any interaction among treatments of particular variables.

RESULTS AND DISCUSSION

Leaf Production

Number of leaves was significantly different among KNO_3 treatments at 24 and 26 WAP, especially application of KNO_3 by foliar (Table 1). In general, number of leaves gradually increased from 2 WAP and reached a maximum at 12 to 20 WAP, thereafter gradually decreased. Some KNO_3 treatments prolonged duration of total growth period, although erratic leaf growth occurred in some plants. This is in contrary by Bhagavan *et al*. (2008) where application of KNO_3 had no effect on leaf parameters of *A. paeoniifolius*.

Life span of first and second leaves was neither significantly different among KNO_3 treatments nor among methods of application (Table 1). However, life span of third leaf was the longest when plants were treated by foliar at rate of 2% and 4% KNO_3, and the shortest when treated with 6% KNO_3 solution (statistically significant). Regardless of KNO_3 concentration and application methods, 2 leaves coexisted in 70 to 93% of plants and 3 leaves coexisted in 13 to 17% of plants. When 6% KNO_3 was applied, 3 leaves coexisted only in 3% of plants. Application by foliar spray increased coexist 3 leaves, i.e., 18%, while soil spray had 9%. Sugiyama and Santosa (2008) suggested that prolong vegetative period will enhance productivity of *Amorphophallus*.

Leaf Size

First leaf size was not affected by treatments (Table 2). Santosa and Sugiyama (2007) stated that first leaf size was dependent on seed corm size; larger corm produced larger leaf. When plants were applied with 6% and 8% KNO_3 through foliar, many third leaves showed larger number of abnormality such as smaller size than normal, and had thick, narrow or non-dissected leaflets than less levels. However, it is still unclear whether abnormality related to KNO_3 application. Interestingly, KNO_3 treated plants through soil spray at rate 4 to 8% increased significantly the second and the third leaves size (Table 2).

In this experiment, productivity was likely determined by size of leaf blades. Since total photosynthetic ability was determined by length of the rachis represented width of canopy, longer rachis and larger number of leaflets indicated wider leaf area. The number of leaflets of the first, the second and the third leaves of normal plants were 14, 32 and 34 units on average, respectively. Number of leaflets was not affected by any treatments.

Some plants from KNO_3 treatments produced small third leaves. We speculated that small size of the third leaf due to disturbance on the expansion. Moreover, some second leaves expressed abnormality like mosaic virus attack, that presumably affected the expansion of subsequence leaves. But we could not clarify factor determining the leaf expansion of the third leaves.

There was a tendency that foliar spray stimulated leaflets browning, especially on their edges of old leaves of first, second and third leaves. Leaf browning on the third leaflets was the least when 2% KNO_3 was applied, i.e., less than 10%. Increasing KNO3 concentration from 2% to 8% increased browning, stimulated senescence of leaves. Plants treated by 4% to 8% concentrations, browning covered about 60 to 80% of population, but percentage of leaflets in each plant severe browning varied from 2 to 90%. Although browning mainly on the leaflet edges, it likely reduced the total leaf area by about 20 to 30%.

Plant Productivity

Application KNO_3 at rate up to 4% through soil significantly increased canopy and corm dry mass at 16 WAP (Table 3). At 16 WAP and 24 WAP, applications of KNO_3 by soil spray tended to increase the root dry mass, while in the contrary by foliar spray. However, at rate of 8% KNO_3 root dry mass significantly the largest among foliar treatments, while the smallest among soil treatments at 24

Table 1. Number of leaf, leaf life span and percentage of plants which produced the second and the third leaves of *A. muelleri* applied with different concentrations of KNO_3 solution using different application method

Treatment		Number of leaf							Leaf life span (weeks)[Z]			Leaf production (%)[W]	
Mode	KNO_3 level (%)	14	16	18	20	22	24	26	First[Y]	Second	Third	Second	Third
		....	....	....	WAP	....	....	....					
Foliar	0	2.1±0.1	2.1±0.1	2.1±0.2	1.7±0.3	1.3±0.1	1.2±0.1	0.5±0.2	14.0±0.6	15.6±0.2	6.0±0.0	100±0	13±4
	2	1.9±0.1	1.9±0.1	1.9±0.1	1.9±0.2	1.3±0.1	1.0±0.1	0.8±0.1	13.9±0.5	15.7±0.9	7.3±0.6	93±5	20±9
	4	2.0±0.1	2.0±0.1	2.2±0.2	2.0±0.2	1.5±0.1	1.5±0.1	0.9±0.2	14.4±0.7	15.3±0.1	8.1±0.7	100±0	53±5
	6	2.0±0.1	1.9±0.1	1.9±0.1	1.7±0.2	1.1±0.1	0.8±0.1	0.5±0.1	14.3±0.5	16.1±0.2	-[V]	100±0	-
	8	1.9±0.1	1.9±0.2	1.8±0.2	1.5±0.1	1.1±0.1	0.9±0.1	0.3±0.1	14.3±0.7	14.7±0.1	7.0±0.6	93±5	20±9
	Total	2.0±0.1	2.0±0.1	2.0±0.1	1.7±0.2	1.3±0.1	1.1±0.1	0.6±0.1	14.2±0.6	15.5±0.3	7.1±0.6	97±2	24±2
Soil	0	1.9±0.1	1.9±0.1	1.9±0.1	1.7±0.2	1.2±0.1	1.1±0.1	0.9±0.1	14.7±0.7	15.9±0.3	3.0±0.0	93±5	7±2
	2	2.1±0.1	2.1±0.1	2.1±0.1	1.8±0.2	1.3±0.1	1.1±0.1	0.7±0.1	15.7±0.7	17.3±0.4	9.3±2.5	100±0	13±5
	4	2.0±0.1	1.9±0.1	1.9±0.1	1.8±0.2	1.1±0.1	1.0±0.1	0.6±0.2	14.0±0.9	15.7±0.5	2.7±0.0	100±0	7±5
	6	1.9±0.1	1.9±0.1	1.9±0.1	1.9±0.1	1.1±0.1	1.0±0.2	0.6±0.2	15.5±0.9	16.1±0.9	5.3±0.0	93±5	13±5
	8	2.0±0.1	2.0±0.1	2.1±0.1	2.0±0.1	1.3±0.1	1.2±0.2	0.8±0.2	15.3±0.3	16.3±0.5	6.0±0.6	100±0	13±5
	Total	2.0±0.0	2.0±0.1	2.0±0.1	1.8±0.1	1.2±0.1	1.1±0.1	0.7±0.2	15.0±0.6	16.3±0.6	5.3±0.7	97±1	12±2

Mean±S.E.

[Z] Measured from full expanded leaves about 4 to 5 weeks after emergence to senesce; including abnormal leaves; [Y] First emerge leaf was considered as first leaf, subsequent leaf was number two, and so on; therefore, its life span was not included in the analysis; [W] Percentage was measured from 15 individual, including abnormal leaves; [V] Leaves severe browning thus excluding from analysis; WAP = week after planting

Table 2. Leaf size of *A. muelleri* treated with different KNO_3 concentration and different application method

Treatment		First leaf[Z]			Second leaf			Third leaf		
Mode	KNO_3 level (%)	Height (cm)	Rachis length (cm)[Y]	Petiole diameter (cm)	Height (cm)	Rachis length (cm)	Petiole diameter (cm)	Height (cm)	Rachis length (cm)	Petiole diameter (cm)
Foliar	0	48.7±1.0	27.7±0.8	1.2±0.1	75.2±3.1	41.5±1.3	1.9±0.1	74.8±18.6	35.2±6.9	1.7±0.2
	2	44.1±3.5	26.8±0.7	1.2±0.0	62.1±4.6	38.9±0.1	2.0±0.1	51.4±17.1	25.5±1.2	1.6±0.1
	4	40.3±1.0	26.4±0.4	1.3±0.1	68.6±1.8	42.9±1.9	2.0±0.1	47.7±8.0	29.3±5.1	1.6±0.2
	6	49.4±1.0	29.1±0.4	1.3±0.0	77.5±0.6	42.8±0.2	2.1±0.0	-[X]	-	-
	8	39.0±4.2	27.7±0.7	1.3±0.0	63.8±2.3	40.6±1.5	2.1±0.0	24.0±13.4	17.0±8.8	1.1±0.5
	Total	44.3±1.9	27.5±0.7	1.3±0.0	69.4±4.0	41.4±1.7	2.0±0.1	49.5±10.5	26.7±5.7	1.5±0.2
Soil	0	48.3±1.0	30.5±0.3	1.5±0.1	75.0±2.5	44.3±1.4	2.1±0.1	0[W]	0	0
	2	46.9±2.1	28.3±0.8	1.3±0.0	68.0±3.4	40.5±2.4	1.9±0.1	69.4±5.0	38.7±0.9	1.8±0.0
	4	49.8±2.1	28.5±1.0	1.3±0.1	78.0±5.3	42.1±2.3	2.0±0.1	-	-	-
	6	47.9±2.2	28.5±0.7	1.3±0.0	78.6±1.4	42.8±1.7	2.1±0.1	-	-	-
	8	49.4±1.6	28.8±0.4	1.3±0.0	81.2±1.6	42.7±0.2	2.0±0.1	67.6±10.6	32.8±1.7	1.6±0.1
	Total	48.4±1.6	28.9±0.6	1.3±0.0	75.4±3.4	42.5±1.6	2.0±0.1	54.6±5.2	29.6±1.3	1.5±0.1

Mean±S.E.
[Z] First leaf was initial leaf after planting, second and third leaf was the subsequence leaves; [Y] Measured from tripartite to distal leaflet tip, three times in a plant. N = 5; [X] Data excluded from the analysis because the leaf show abnormal size; [W] Leaves fail to develop in sample plants

WAP. Table 3 showed that canopy and root dry mass almost stable from 16 WAP to 24 WAP, on the other hand corm dry mass increased 3 to 4 fold irrespective of KNO_3 levels and method of applications.

Foliar application did not affect significantly on dry mass of canopy and corm, but it significantly reduced root dry when KNO_3 level less than 8%. Low corm production at 6 and 8% KNO_3 applications might be related to the

Table 3. Dry mass of canopy, seed corm, corm and root of *A. muelleri* grown in pot treated with different KNO_3 concentration and method of applications at 16 and 24 WAP

Treatment		16 WAP				24 WAP		
Mode	KNO_3 level (%)	Canopy (g)	Seed corm (g)	Corm (g)	Root (g)	Canopy (g)	Corm (g)	Root (g)
Foliar	0	39.7±3.9	-[Z]	35.9±14.9	10.0±1.6	41.3±4.9	84.7±21.4	6.9±1.3
	2	36.9±0.8	0.2±0.2	28.0±9.0	7.7±0.3	36.9±3.5	98.5±3.8	6.3±0.4
	4	33.7±3.9	-	39.3±12.6	6.9±0.9	37.4±4.3	103.3±8.2	4.8±1.3
	6	33.8±4.5	-	19.5±5.2	4.9±1.3	27.0±11.4	87.8±26.6	4.6±1.9
	8	40.2±4.9	-	28.8±12.3	8.9±1.6	41.0±4.5	118.1±18.5	11.4±2.5
	Total	31.2±3.3	-	26.2±9.1	7.0±1.2	30.6±5.5	91.6±13.5	5.7±1.5
Soil	0	40.6±2.0	0.4±0.3	23.7±5.1	7.3±1.3	20.0±8.1	73.0±27.1	2.0±0.8
	2	45.4±1.4	-	49.6±3.6	10.4±0.5	39.1±8.9	75.6±0.8	5.1±1.4
	4	53.1±4.0	-	35.2±9.8	8.4±1.8	26.9±5.6	66.6±17.1	5.1±1.8
	6	35.8±2.0	-	23.5±6.1	9.0±0.2	30.1±6.8	102.0±9.5	5.4±2.9
	8	43.4±2.6	-	20.6±5.2	8.4±1.1	10.4±8.1	75.2±17.3	0.4±0.2
	Total	36.4±3.0	-	26.8±5.4	7.5±0.8	25.3±6.5	78.5±12.7	3.6±1.3

Mean±S.E.
[Z] Seed corm had decomposed completely. At 24 WAP all seed corms from all treatments have completely decomposed; WAP = week after planting

occurrence of leaf browning. On the contrary at 24 WAP, foliar spray with KNO_3 increased dry masses of canopy, corm and roots markedly more than soil spray. At harvesting time, many petioles from foliar treated plants were still green unlike senescent plants, suggesting that leaves were still active. Therefore, if we could minimize the leaf browning, the foliar application of KNO_3 is promising to enhance *A. muelleri* productivity through extension of vegetative stage.

Table 4 shows that fresh weight, corm size, glucomannan content and percentage of dry mass content was not significant different among methods of application. At 16 WAP, the KNO_3 treatments affected corm productivity, but not at 24 WAP and at harvest (Table 3; Figure 1). Santosa *et al*. (2011) stated that application of N larger than 50 kg ha^{-1} decreased corm yield of *A. muelleri* irrespective of level K_2O applications. In this experiment, additional N applied in every two weeks was 2.6 kg ha^{-1} for 2% KNO_3 to 10.2 kg ha^{-1} for 8% KNO_3, thus, ranging from 81.2 to 172.4 kg N ha^{-1}, including basal N application. In line with Santosa *et al*. (2011) conclusion, it is likely that excess N application caused application of KNO_3 less effective to increase corm yield in this experiment.

Figure 2 showed ratio of canopy to corm dry mass, indicated that corm dry mass increased steadily from 8 to 24 WAP. At 16 WAP, application of 8% KNO_3 had larger ratio than 2% KNO_3. Lower corm weight from 4, 6 and 8% KNO_3 at 16 WAP is probably related to lower assimilate ability due to high incident of leaf browning. Table 1 showed that after 14 WAP leaf number of 8% KNO_3 treatment started to decrease.

In order to understand the role of canopy on dry mass accumulation, pruning treatment was done in additional of control plant at 8, 16, 24 and 27 WAP. Figure 2 showed that pruning leaves at 16 WAP significantly decreased the ability of *A. muelleri* to maintain canopy dry mass. Those condition lead plants to have low corm dry mass as shown in Figure 1.

In general, roots still active at 24 WAP irrespective of treatments. On the other hand, canopy weight tended to decrease while corm weight increased markedly from 16 WAP to 24 WAP. At level of 2% and 4% KNO_3 applications, canopy dry mass decreased by less than 10% during this period, while it decreased by larger than 25% in other KNO_3 treatments and control. Although KNO_3 treated plants through foliar at level larger than 4% had larger vegetative biomass (Table 1), however, due to high incident of leaf browning caused plants to produced lower glucomannan content (Table 4).

Foliar application of KNO3 significantly decreased total glucomannan content, but the content did not significantly different to control among KNO_3 levels when applied through soil spray. KNO_3 application of 4% and 8% through soil resulted in the lowest corm fresh weight. It is likely that application of KNO_3 affected enzymes activity responsible for starch accumulation. Further research is needed to understand the mechanism of enzymes activity related to KNO_3 applications.

Table 4. Corm size and dry mass content of *A. muelleri* grown from different KNO_3 treatments and method of applications

Treatment		Corm size^Z			Glucomannan content (g)^Y	Dry mass (%)
	KNO_3 level (%)	Fresh weight (g)	Diameter (cm)	Height (cm)		
Foliar	0	527.3 ±38.9	106.3±3.9	71.4±2.4	47.8±3.9	17.9±0.4
	2	399.1 ± 8.6	100.7±2.0	65.5±1.0	37.3±2.5	18.1±0.6
	4	493.3 ±59.9	104.8±4.7	71.6±4.2	43.3±1.4	17.8±0.9
	6	508.3 ±47.1	102.0±1.8	73.0±3.8	36.5±1.8	18.0±0.9
	8	458.6 ±19.6	103.3±2.0	72.2±0.9	36.9±0.9	18.1±0.9
	Total	477.3±30.2	103.4±2.8	70.7±2.3	40.4±2.1	18.0±1.0
Soil	0	502.9 ±21.8	108.2±1.1	72.1±1.2	40.3±4.7	18.9±2.2
	2	502.2 ±17.2	103.0±0.6	74.6±2.1	43.7±5.9	17.5±0.5
	4	426.9 ±31.3	101.2±2.9	71.6±2.7	37.5±2.0	19.0±1.0
	6	507.7 ± 3.3	105.0±2.5	71.9±1.2	41.6±0.7	18.0±0.2
	8	431.5± 7.5	103.2±2.2	67.9±3.1	38.3±3.5	18.3±0.7
	Total	474.2±16.0	104.1±2.1	71.6±2.2	40.3±3.0	17.3±0.7

Mean±S.E.

^{Z} Corm shape was mostly globose. Diameter was measured from the widest part; ^{Y} Glucomannan content was estimated from 55% of total dry mass

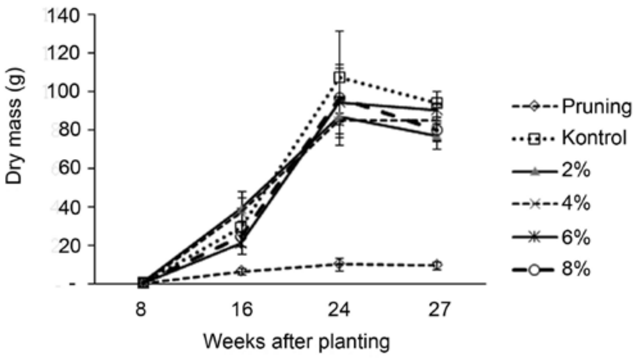

Figure 1. Effect of KNO_3 application on corm dry mass of *A. muelleri*. First KNO_3 was applied at 12 WAP, then twice a month. Bar±S.E

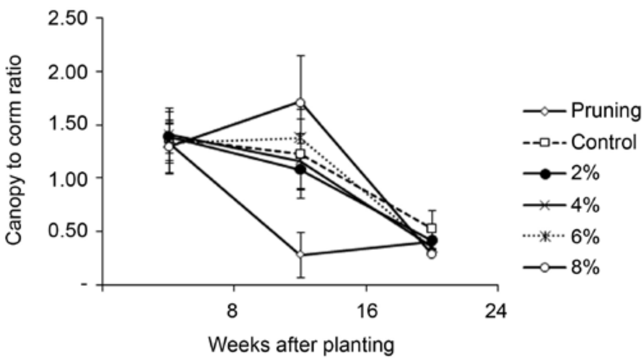

Figure 2. Effect of KNO_3 application on ratio canopy to corm dry mass of *A. muelleri*. First KNO_3 was applied at 12 WAP, then twice a month. Bar±S.E

CONCLUSIONS

KNO_3 application through foliar treatments was more effective to increase number and life span of third leaves of *A. muelleri* than soil treatments. At rate of 2% and 4% KNO_3, plants from foliar application produced higher number of leaf than those of control and other treatments. KNO_3 treatment did not significantly increase corm production but foliar treated plants tended to have larger corm dry mass than those of soil ones. Soil spray application promoted plants to produce larger canopy and roots dry mass. However, foliar application of KNO_3 promoted leaflets browning lead plant to produce abnormal leaf, therefore, it is important to increase the effectiveness fertilizer through foliar application by restricting browning.

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