Middle-East Journal of Scientific Research 12 (1): 75-79, 2012
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2012.12.1.1661

Effect of Mowing on the Growth of above Ground Parts of Solanum Rostratum Dunal

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Abstract: By the method of mowing to harvest the Solanum ro stratum and testing serial indicators such as height, leaf number of the plants and lateral branches and duration of vegetative growth, we find out that the most suitable mowing node of controlling Solanum rostratum was the first and the forth node. The results showed that the duration of vegetative growth tends to increase, with the cutting node increases, and that effect on the plants which were cut on the first, forth, sixth and seventh node were significant; the length and the leaf number of the longest lateral branch tends to decrease, and that of the plants which were cut on the seventh node decreases remarkably; there is no significant difference on plants height the sum of length and the sum of leaf number of lateral branches among all treatments.

Key words: Growth · Mowing · Solanum rostratum · Lateral branches

INTRODUCTION

Solanum rostratum Dunal. is an alien invasive plant in China, belongs to annual herbage. Its blooming period is from June to August every year, which could extend to October. *Solanum rostratum* originates in North America. It was first found in Liaoning province, and then was also found in Beijing, Jilin province, Shanxi province, Hebei province successively [1-2]. Solanum rostratum is a kind of malignant weed, poisonous and inedible for livestocks. And it makes a lot of trouble to agricultural production and people's daily life. If it spreads widely, the native biodiversity may reduce. Nowadays, *Solanum rostratum* was controlled by eradicating roots and herbicides. However, the method of eradicating roots consumes manpower and material resources, and herbicides may bring about some negative effects on farmland and the environment. As an agronomic means, if using suitably, cutting may largely influences regeneration property of plants [3-5]. Recently, some researchers showed that moving can prevent *Spartina alterniflora* and *Rhododendron flavum* in a suitable period [6-8]. But we do not know the effects of cutting on the growth of above ground parts of *Solanum rostratum*. Once the method of cutting is found, *Solanum rostratum* can be controlled without too much consumption of man power and material resources.

Objectives of the Study:

- To explore the effect of mowing to lateral branches *of Solanum rostratum*
- To find out the best mowing position of *Solanum rostratum*

MATERIALS AND METHODS

Experimental Design and Treatments: Seeds of *Solanum rostratum* Dunal, were collected in Chaoyang, Liaoning province China and were soaked into hot water of 70°C. After soaking for several hours, seeds were cooled and dried naturally. Then seeds were grinded with motor appropriately, until the explore were worn, then washed seeds with clean water. Seeds were packaged with maid gauze into thermostat of 28°C. When the buds are up to 3 to 5mm the 2 to 3 seedlings were transferred into one plastic pot. Total post used were 27 in this experiment. After several days of growing, only 1 plant was selected from every plastic

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pot. When these plants had well growth very well, data was recorded as plant height and leaf number after every six days, divided the plants of 27 plastic flowerpots into 9 groups randomly. The ninth group is control group which have no mowing. The first group is mowed between the first and second node of *Solanum rostratum*. The second group is mowed between the second and third node, follow this rule up to the eighth group. The treatments were made until the plant grow to appropriate nodes. Scissors were used to cut off the branches of plants from different node of different groups, then recorded the plants height, the number of lateral branches, the length and the leaf number of lateral branches, and the duration of vegetative growth. T_1 was the duration from May 10th of 2010 (the day we started to record) to the day plants bloom. T_2 was the duration from the day plants were cut to the day in which plants bloom.

Statistical analysis: Statistical of plants height before the day plants were cut were analyzed by F test. Significance level was $p<0.05$ and $p<0.01$ for any difference in mean values among treatments by Ficher's LSD test. Differences were analyzed using one-way ANOVA, using Statistic Package for Social Science (SPSS 15.0).

RESULTS AND DISCUSSION

Test of Consistency of Growth of Solanum Rostratum: According to F test, there is no significant difference in plants height among treatments before cutting.

The Effects of Cutting Treatment on Duration of Vegetative Growth: The duration of vegetative growth is a direct indicator showing the effects of cutting on prolonging the growth period, meanwhile, in some cases, it also shows the capacity of regrowth of *Solanum rostratum* after cutting. According to the mean values, t1 values were larger than that of control groups, and there is significant difference in the t1 values between treatment group and control group ($P<0.05$); meanwhile there are significant differences in t1 values between group 1, group 4, group 6, group 7, group 8 and control group($P<0.01$). At first, t2 value have a little tendency to increase, and is up to the maximum value at group 4. Then , t2 tend to reduce obviously. And there is a very significant difference in t2 values between group 1, group 2, group 3, group 4, group 5 and group 6, group 7, group 8, group 9 on t2 values ($P<0.01$). That account for *Solanum rostratum Dunal* can regenerate rapidly and bloom, when we cut on the sixth node.

The Effects of Cutting on Plants Height: The significance analysis of the statistics of plants height of control group and those of treatments groups by LSD test, and the results show that there are significant differences in plant sheight between group 1, group 6, group 7, group 8 and control group ($P<0.05$), and the plant height of group 1 and group 6 are significant lower than that of control group. For treatment groups, not only are there very significant differences in plant height between group 1 and group 6, group 7, group 8($P<0.01$), but also the plant height of group 7 and group 8 is significant higher than that of control group. That is to say, cutting treatment has effects on plant height of *Solanum rostratum* when cut on the first and the sixth node.

The Effect of Cutting on Growth of Lateral Branches: Normally, the apical dominance of *Solanum rostratum* is obvious, the lateral branches don't develop to much before blooming. Only when the tip is cut, lateral buds that located in leaf axil will develop to lateral branches. Therefore, the status of growth of lateral branches can directly indicate the regrowth status of plants. Usually length and leaf number of lateral branch characterized the growth status of lateral branch; actually, the regenerate lateral branch on the top will occupy the apical dominance once again; so length and leaf number of the longest lateral branch characterized the regrowth property of plant. We can conclude from the table 4 that there is no significant relationship among the sums of length of lateral branches of these treatments,

Table 1: Significance test of difference of plants height

	df	Sum of Squares	Mean Square	F	Sig.
Between Groups	8	47.027	5.878	1.279	.314
Within Groups	18	82.720	4.596		
Total	26	129.747			

*Values represent means ± SE of three replicate experiments. Within each column, mean values followed by different lower-case letters are significantly different at $P<0.05$ and followed by different capital letters are significantly different at $P<0.01$ according to Ficher's LSD test.

Table 2: Significance analysis of t1 and t2

Treatment	t1 (d)	t2¨d©
1	74.0±0.0 eC	48.0±0.0 cC
2	58.0±4.0 bAB	38.0±4.0 bBC
3	58.0±4.0 bAB	38.0±4.0 bBC
4	64.0±2.0 bcdBC	44.0±2.0 bcC
5	58.0±2.0 bAB	38.0±2.0 bBC
6	62.0±3.5 bcBC	28.7±1.8 aAB
7	68.0±3.5 cdeBC	24.0±3.5 aA
8	72.0±2.0 deC	21.0±2.0 aA
9	48.7±4.3 aA	28.7±4.3 aAB

*Values represent means ± SE of three replicate experiments. Within each colum, mean values followed by different lower-case letters are significantly different at P<0.05 and followed by different capital letters are significantly different at P<0.01 according to Ficher's LSD test.

Table 3: Significance analysis of plants height

Treatment	Plants height (cm)
1	0±0 aA
2	18.17±0.17 bcBC
3	20.17±0.83 bcdBC
4	18.83±0.44 bcdBC
5	21.33±1.01 cdBC
6	16.67±1.17 bB
7	22.33±2.33 dC
8	22.17±2.24 dC
9	21.67±0.88 cdBC

*Values represent means ± SE of three replicate experiments. Within each column, mean values followed by different lower-case letters are significantly different at P<0.05 and followed by different capital letters are significantly different at P<0.01 according to Ficher's LSD test.

and LSD test shows that there are significant differences in sum of lengths of all lateral branches between group 1, group 9 and group 5, group 6 (P>0.05), in the meantime, the sum of lengths of all lateral branches of group 5 is significant larger than that of group 6, which account for that status of regeneration of *Solanum rostratum* is worst when it was cut on the sixth node, and that was as same as the plant height. For the length of the longest lateral branch, with the cutting node increased ,the length of the longest lateral branch tend to increase at first, and then tend to decrease, but there is no significant difference among group 2, group 3, group 4 and group 5(P>0.05), however the length of the longest lateral branch of group 6 and group 7 decreased significantly. This may because of that group 2, 3, 4 and 5 were cut earlier than group 6 and 7.

Table 4: Significance analysis of sum of lengths of all lateral branches that of length of the longest lateral branch

Treatment	Sum of lengths of all lateral branches (cm)	Length of the longest lateral branch (cm)
1	0.00±0.00 aA	0.00±0.00 aA
2	15.50±0.00 bcB	15.50±0.00 dC
3	18.83±2.32 bcB	16.83±1.01 dC
4	15.00±0.00 bcB	13.00±1.00 cdBC
5	20.33±0.73 cB	13.33±1.59 cdBC
6	13.50±0.87 bB	8.67±1.20 bB
7	17.33±5.09 bcB	8.33±2.09 bB
8	16.17±3.44 bcB	9.50±2.75 bcB
9	0.00±0.00 aA	0.00±0.00 aA

*Values represent means ± SE of three replicate experiments. Within each column, mean values followed by different lower-case letters are significantly different at P<0.05 and followed by different capital letters are significantly different at P<0.01 according to Ficher's LSD test.

Table 5: Significance analysis of sum of leaf number of all lateral branches that of leaf number of the longest lateral branch

Treatment	Sum of leaf number of all lateral branches	Leaf number of the longest lateral branch
1	0.00±0.00 aA	0.00±0.00 aA
2	7.67±0.67 bB	7.67±0.67 dD
3	9.00±1.00 bcBCD	7.67±0.33 dD
4	8.00±0.58 bBC	7.00±0.58 cdCD
5	11.00±1.00 cdCD	6.00±0.00 bcBCD
6	9.00±0.00 bcBCD	5.67±0.33 bcBC
7	11.67±1.76 dD	5.00±0.58 bB
8	9.67±0.33 bcdBCD	4.67±0.88 bB
9	0.00±0.00 aA	0.00±0.00 aA

*Values represent means ± SE of three replicate experiments. Within each column, mean values followed by different lower-case letters are significantly different at P<0.05 and followed by different capital letters are significantly different at P<0.01 according to Ficher's LSD test.

The leaf blade of lateral branch hold the most of biomass of regenerate branches, and it is the main organ of photosynthesis, so that the number of leaf blade can be used to represent the regeneration state of plant in some degree. According to the table 5, we can conclude that, with the cutting node increase, the sum of leaf number of lateral branches increase, and there are very significant differences in sum of leaf number of all lateral branches between group 2 and group 5, group 7(P<0.01). Group 1 and group 9 have no lateral branch, so it is natural that there are very significant differences in sum of leaf number of all lateral branches between those and other groups. Group 1 has no lateral

branch, so it has no leaf of lateral branch. Group 2 has the least leaf number of lateral branches, and group 7 has the most of that. The reason is that the plants which were cut from the second node can only develop 2 lateral branches from leaf axil at most, which may limit the leaf number of lateral branches. On the other hand, the point of cutting is so low that it harms the plants seriously, as a consequence, group 2 need more time to regeneration; on the contrary, the plants of group 7 were cut on the seventh node, these plants could develop more branches from multiple leaf axil, and cutting harm these plants more slightly. Meanwhile, the most of vegetative organs are reserved, hence, the plants regenerate rapidly, and the duration of regeneration is short.

Leaf number of the longest lateral branch tend to increase at first, and then tend to decrease, with the cutting node increase, but there is no significant difference between group 2 and group 3($P>0.05$), that is to say, the tendency of increase is not significance. That is different from the increase tendency of the sum of leaf number of lateral branches, which suggests that with the cutting node increase, the potential number of the regenerate branches is increasing, but the leaf number of the longest lateral branch is decreasing.

DISCUSSION

There is no significant difference on plants height among all plants before cutting, which shows that the differences of fertility of soil and other environmental factors and management do not exist. When analyzing the statistics which were measured after cutting, we found cutting between the eighth node and the ninth node can prolong duration of vegetative growth contently, but there is little practical significance on it, because the plants of control group and the most of all plants of treatment groups had been bloom before they grew to the eighth node. Therefore, according to the aim of our experiment, actually, the statistics of group 8 is not of use almost. Additionally, because of the death of the group 1 after cutting and there is no lateral branch developing on plants of group 9, the default t1 values of group 1 are defined as 74 days (the longest time of experimental plants from the day we started to record to the day plants bloomed), and length and leaf number of lateral branch of group 1 and group 9 are considered as 0.

We cultivated the seedlings in early spring, which is not accord with the natural germination time of *Solanum rostratum*, and the temperature of room is relatively low. All of those may lead to random errors. Soil and climate in room is different from farmland, so the vegetative growth and reproductive growth may turn out to different status, further research should be done.

We don't consider the effects of the time when we cut in the experiment. With the cutting node increases, the time of cutting is later, the roots of *Solanum rostratum* are stronger, the diameter of stem and leaf increases, and nutritive matter which is stored increases, too, so regeneration property of plant increases evidently; in addition, it is impossible that the growth status of experimental plants are uniform completely. Therefore, in the case of the smaller plants as well as the bigger plants are cut on the same appropriate node that meets the requirements, we may get different results.

As to plants height, there is no significant difference between treatment groups and control groups, meanwhile, the number of branches increased, so in some degree, we can say that cutting treatment can promote the vegetative growth. Just because of that , reproductive growth is restrained. That accords with Pei Xin's result of which cutting treatment can improve ground biomass significantly [3], GUO Zhi-hui's result of which grain yield of fodder maize KD8 increased significantly when cutting at booting stage [4].

The results of experiment show that cutting from first node can lead *Solanum rostratum* to die, the function of prevention is obvious; cutting from the forth, sixth and seventh node can restrain or prolong the duration of vegetative growth; what is more, the effect is best when it was cut on the forth node; from biomass, lateral branch growth and plant height can be restrained utter mostly when cutting on sixth node. But it seems not factual to restrain its bloom by cut only once. We may also take something into consideration such as the cutting frequency and biological substitute.

Experiment gives a reference for ensuring the best cutting frequency to prevent *Solanum rostratum.*. The results shows that when plants are cut on the forth node, *Solanum rostratum* need much more time for regrowth, and we can prolong the interval of cutting, which may reduce the cutting frequency. Moreover, that cutting interval (44d) matches harvest interval of certain forage(43d~55d) [8], and plant height of *Solanum rostratum* on the forth node in field near harvest

height(10cm~15cm) of forage, therefore, just as the same as harvest forage, we can inhibit reproductive of *Solanum rostratum*. But, because of the toxicity of *Solanum rostratum*, quality of forage will be reduced when we harvest forage with *Solanum rostratum*, but when the number of *Solanum rostratum* is small, and requirements to quality of forage are not too high, we may take this way in to consideration.

ACKNOWLEDGMENT

This research was supported by Special Fund for Agro-scientific Research in the Public Interest (No. 201103027) and National Science and Technology Major Project of the Ministry of Science and Technology of China (No. 2012ZX07202-004-01)

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