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The effect of N fertilizer and methanol spray on function and growth procedure of aerial organs of *Beta vulgaris* var. in Karaj and Moghan areas

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ABSTRACT: To study the reaction of *Beta vulgaris* varieties to N levels and methanol spray and also to study changes of efficiency indexes of plant's N and soil's N, an experiment was done during 2013 in two regions including research station of Motahari in Karaj and Oltan agricultural research institute in Moghan as strip split blocks with 4 times repetitions. Under studied factors were 4 levels of N (control), efficiency level (according to soil test and previous studies), 25 and 50% lower than efficiency level, 4 varieties of *Beta vulgaris* including Pars, Ekbatan, Razir and Flores and also zero solvent (control treatment without using methanol), 10 and 20% by volume of methanol. N was applied in 5 parts with definite intervals and methanol was sprayed on aerial organs in 3 times during growth seasons with 14 days interval. According to Bartlet results about measured characteristics (number of leaves per m^2 and number of falling leaves per m^2), there is significant difference in two regions, therefore aforementioned characteristics were analyzed. Regarding the table of variance analysis, the effects of treatments (N, variety, and methanol and interaction effects) were significant in both regions. In addition, regarding statistical results, application of N had not significant effect in 1 and 5% on the number of falling leaves in Moghan region. As a conclusion, when warm seasons begin in Moghan region (in the late of June and August) the leaves started to flow and again at the end of September they grew because of better climate.

Key words: *Beta vulgaris*, leaf, methanol spraying, Nitrogen

INTRODUCTION

One of the main reasons of low cutie of *Beta vulgaris* in Moghan is high temperature of nights in August and September months and extreme reduction of light during days (Yadollahi and Shojaei-Asadieh, 2009).

Fathollah Taleghani *et al*. (2001) suggested that aerial organs have grown more quickly and reach to their highest level in this region than other areas (such as Karaj). But this plant cannot maintain the produced aerial organs following with their growth; when temperature increases in June and August, the leaves start to fall and by reduction of temperature in September aerial organs grow again. This causes that sugar percentage of product decreases and eventually in harvesting time, the sucrose amount existing in the root decreases in comparison with spring *Beta vulgaris* of other areas.

In the other study in Germany, it was indicated that high temperature in June and August reduces final function of the root, therefore the function of white sugar reduces in the fall. In October, the accumulation of dry matter of roots was affected by intensity of radiation obviously. During summer, higher temperature than the mean is harmful for the function (Kenter and Hoffman, 2003; Kenter *et al.*, 2006).

In a study that was carried out to consider the situation of agriculture and production of *Beta vulgaris* in 2006 and 2007 it was determined that in 2007 the average cutie of delivered *Beta vulgaris* to sugar companies was the most amount of cutie record in Iran. Researcher claimed that cool weather in summer and delay of irrigation during harvesting time in the fall and also reduction of moisture level existing in the roots of *Beta vulgaris* are the main reasons of aforementioned record (Abdollahian-Noghabi, 2008).

Lack of N causes limitations in roots' system, short length of bushes, reduction of leaf surface index, reduction of absorbance level, enhancement of light's efficiency and functional damages (Cox *et al.*, 1993).

N has significant effect on plant's appearance, and the most important effect is improvement of plant's color and quick development of canopy. This issue sometimes causes over use of N in the soil that leads to reduction of purity of *Beta vulgaris* (Cook and Scott, 1993).

The relation between N of the plant (which is a function of soil's N) doesn't reach to constant pattern by allocating dry matter between aerial and underground organs (Webb *et al.*, 1997).

Therefore, under some conditions, photosynthesis materials may allocate to aerial organs and the allocated ratio to underground organs reduces and vice versa. The experimental evidences have shown that N that is existed in plant has key role in determination of transformed pattern of materials between aerial organs and root (Schoper and Gunderson, 1978).

Application of N fertilizer increases the growth of aerial organs, while if there was not available N, plant distributes materials mostly for providing stored root growth in comparison with aerial organs (Webb *et al.*, 1997). Application of N can have important role in enhancement of leaf area's durability and production of dry material (Yin et al., 2000).

Methanol is one of the materials that increase the consistency of CO2 in tricarbonic plants. In addition it can act as a rich carbon source in a condition that photorespiration is being done by plant, and can compensate parts of loss carbon that was stabled during photosynthesis by enhancement of CO2 concentration inside the plant and enhancement of photosynthesis efficiency. Methanol is produced in cell wall through demethylation of pectin (Makhdum *et al.,* 2002).

Methanol application on aerial organs of cotton plant causes enhancement of dry material, reduction of leaf temperature, enhancement of pure photosynthesis of the leaf, enhancement of seed function and reduction of plant's required water (Sawan e*t al.,* 2001).

Nadali *et al.* (2007) studied *Beta vulgaris* and showed that there is significant difference between various levels of solutions on some characteristics such as root's function, leaf function, sugar function, extraction ratio, alkaline degree, harmful N, sugar and white sugar function. But sugar percentage, harmful sodium and potassium were not affected by methanol levels. The aerial organs of *Beta vulgaris* are valuable and are very useful for animal feed.

In a favorable condition, products of aerial parts may be equal to the products of roots (Koochaki, 1996). There is a significant difference between various levels of methanol and control treatments on leaf function in 1% level. The carried out studies show that methanol treatment in cotton can increase leaf surface index and can be effective on the function of aerial organs (Makhdum *et al.,* 2002). Totally, studies show that application of methanol can increase efficiency of water consumption, reduction of photorespiration, enhancement of leaf surface and durability and finally enhancement of function in most of the agronomical plants (Rowe et al., 1994). The aim of present study is considering the effect of N fertilizer and methanol spray on function and growth procedure of aerial organs of *Beta vulgaris* var. in Karaj and Moghan areas.

MATERIALS AND METHODS

Moghan plain is located in North West of Iran between longitudes of 47.35° and 48.22° and northern latitudes of 39.22° and 39.45° and the mean height from sea level is 60m. Motahari research station is located in North West of Karaj and its geographical situation is 35° and 50" of north latitude and 50° and 58" of east longitude. Its height from sea level is 1313m. The present study was done in 2013 using strip split block in complete accidental plots with 4 times repetitions in two regions with type irrigation system.

Experimental factors included 4 levels of N fertilizers, 4 varieties of *Beta vulgaris* and 3 methanol spray levels. Each main plot included various treatments of N and subsidiary plots included 4 varieties and each variety had 6 lines with 12m length which its cultivation form was 40*50 and bushes distance was about 20cm on cultivation line. In subsidiary plots methanol spray factor had 3 different levels: 1. control treatment (non-application), 2. 10% by volume of methanol and 3. 20% by volume of methanol.

The treatments of N amounts were determined based on concentration of the rest nitrate N in the depth of 0-30cm of soil before cultivation time. The efficient level of nitrate N in 0-30 cm of soil's depth was considered as 25mg/kg on the basis of previous studies.

Table 1: Soil test.

Experimental regions					
Karaj			**Moghan**		
Parameter	**Amount**	**Unit**	**Parameter**	**Amount**	**Unit**
PH	7.48	….	PH	7.82	….
EC	1.03	$Ds.m^{-1}$	EC	1.54	$Ds.m^{-1}$
Na	6.36	$Meq.l^{-1}$	Na	14.89	$Meq.l^{-1}$
P	10.46	$Mg.kg^{-1}$	P	8.46	$Mg.kg^{-1}$
O.C	1.03	%	O.C	0.25	%
K	598.84	$Mg.kg^{-1}$	K	669.64	$Mg.kg^{-1}$
NH_4	5.95	$Mg.kg^{-1}$	NH4	6.3	$Mg.kg^{-1}$
NO_3	14.63	$Mg.kg^{-1}$	NO3	29.82	$Mg.kg^{-1}$
Clay	30.45	%	Clay	51.40	%
Silt	49.85	%	Silt	36	%
Sand	19.70	%	Sand	12.6	%
Soil Texture	Clay-loam	….	Soil Texture	clay	….

Regarding the results of soil test in each of the regions, the N amount was calculated and applied. On this base, the treatments of N fertilizer were: 1. efficient amount, 2. 25% lower than efficient amount, 3. 50% lower than efficient amount, and 4. control treatment without N fertilizer (existed amount of N in the soil). The used fertilizer source was ammonium nitrate which was consumed in 5 parts along with irrigation in drop irrigation type system in various treatments.

Under studied varieties included: 1. Pars, 2. Ekbatan, 3. Razir, and 4. Flores. Spraying time was between 17-20pm. Bush spraying continued till drops flew on the plant. Type irrigation was done on the basis of evaporation amount from class A evaporation pan with 90% efficiency. Irrigation duration was constant and was done every 3 days.

In final harvest 2m length was harvested from 4 middle lines and totally 8m length was cut that was equal to $3.6m^2$. The number and weight of roots were calculated and root dough samples were prepared and their qualified characteristics was measured and evaluated by laboratory of sugar technology institute, in addition dry material percentage was measured by soil chemistry institute.

During plant growth steps and during 7 stages, canopy coverage percentage, number of leaf per bushes, number of leaf per m^2 and number of falling leaves were measured by specific quadrates in all of the treatments.

Achieved data was analyzed by SASv9.2 statistical software and mean comparison was done by LSD test, then graphs were drawn by Excel software.

RESULTS

The results of understudied features in Karaj region

The number of leaves per m^2

According to the results of variance analysis, the feature of number of leaves per m^2 was affected by the main effect of N in 1% level during late June, middle and late August and middle of September. The study of number of leaves per m^2 in various treatments of N shows that N4 treatment in late June and middle of August and N2 treatment in late of August and middle of September and October led to the most number of leaves per m^2.

In addition the study of the process of leaves' number indicated that the least number of leaves was related to N1 treatment in late June, middle of August and also N4 treatment in late August, middle of September and October. Therefore, it can be said that among various N treatments, the number of leaves per m^2 has reduced extremely after an enhancement in aforementioned stages.

This study determined that number of leaves in V1 variety was significantly more than other varieties and led to the most number of leaves in middle of September; while, V3 and V4 had the least number of leaves per m^2. Therefore the most number of leaves was related to V1 and V2 varieties.

Regarding table of variance analysis about number of leaves per m^2 in methanol treatments, methanol had significant effect on number of leaves per m^2 in 5% level in middle of June and September; and also it had significant effect in 1% level in the late June and middle of August and October.

The study of process of number of leaves also indicated that the rising slope of leaves' number was highly intensive in M3 in the late of August and middle of September in comparison with M2 and M1. The leaves' number per m^2 had relatively similar processes in various treatments of methanol, but after the middle of August, the rising slope of leaves' number in M3 treatment was more significant than other treatments.

According to the results of data variance analysis about interaction effects of treatments, the feature of number of leaves per m^2 was affected by interaction effect of N and variety in 1% level in the late June, middle of August and September, it also had significant effect in 5% level in the late of August.

Mean comparison of interaction effect of N and variety in the middle of August showed that N3V1 led to the most number of leaves per m^2 (257.3) and was classified in statistical group of a, and N2V4 achieved the least number (213.7).

The interaction effect of N and methanol had significant effect on number of leaves per m^2 in 1% during middle and late of the August and middle of September and October. The results also showed that the interaction effect of variety and methanol had significant effect on aforementioned feature in 1% level in the middle of August, September and October. The interaction effect of variety and methanol in the middle of August showed that V1M2 and V2M2 led to the most number of leaves per m^2, and V4M2 has allocated the last rank.

Eventually, according to the data variance analysis results, the interaction effect of N, variety and methanol had significant effect on number of leaves per m^2 in 1% in the late June, middle and late of August and middle of September.

Interaction effect of N, variety and methanol in the late of June showed that N2V1M2 led to the most number of leaves per m^2 (180) and was classified in the group a; and N2V4M3 led to the least number of leaves per m^2 (135) and grouped in r.

The number of falling leaves per m^2

Regarding the results of variance analysis, N had significant effect on the number of falling leaves per m^2 in the middle and late of June, middle and late of August and middle of September in 1% level.

The study on the number of falling leaves per m^2 in various treatments of N showed that N3 caused the most number of falling leaves per m^2 in the middle and late of the June, middle and late of the August and middle of September.

The least number of falling leaves per m^2 was related to N2 in the middle and late of the June, middle and late of the August and middle of September. The results of data variance analysis showed that variety treatment had significant effect on the number of falling leaves per m^2 in 1% level during the middle and late of the June, middle and late of the August and middle of September and middle of October. The study on the number of falling leaves per m^2 indicated that the number of leaves in variety of V2 was significantly more than other varieties and had the most number of leaves in the middle of September. While V4 had the least number of falling leaves per m^2 and has allocated the least number of falling leaves in aforementioned date among other varieties.

According to the table of variance analysis about methanol treatment, methanol had significant effect on the number of falling leaves in 5% level during middle of September, it also had significant effect in !5 in the middle of October. The number of falling leaves showed that rising slope of falling leaves is more intensive in the middle of June till the middle of October in M1 treatment in comparison with M2 and M3. The process of number of falling leaves is relatively similar among various treatments of methanol and the slope of increasing number of falling leaves is observable in different treatments. In the middle of September, M1 and M2 caused the most and the least number of falling leaves per m^2 and in the middle of October M1 and M3 have allocated the first and the least ranks orderly.

According to the results of data variance analysis on interaction effects' treatments, the number of falling leaves was affected by interaction effect of N and variety in 1% level in the middle and late of June, middle and late of August, middle of September and October.

Interaction effects of N and methanol were significant on the number of falling leaves per m^2 in 1% in the middle and late June, middle and late of August and middle of September, it also was significant in 5% level in the middle of October.

Interaction effects of N and methanol showed that N3M1 and N3M2 have allocated the most number of falling leaves per m^2, in the middle and late of June, middle and late of August and middle of September; in addition N1M2 has led to the least number of falling leaves. According to the results of data variance analysis table, the treatment of N2M1 caused the most number of falling leaves (78.12) in the middle of October and was grouped in class a; while N4M3 has allocated the last rank (64.1).

The results showed that interaction effects of variety and methanol were significant on the aforementioned characteristic in 1% level in the middle and late June, middle and late of August and middle of September and October. Interaction effect of methanol and variety showed that V2M2 led to the most number of falling leaves per m^2 and V4M2 has allocated the last rank.

Finally, according to the data variance analysis, interaction effect of N, variety and methanol was significant on the number of falling leaves in 1% level during middle and late of June, middle and late of August, middle of September and October.

The results of understudied features in Moghan region

The number of leaves per m^2

According to the results of variance analysis, N had significant effect on the number of leaves per m^2 in 1% in the middle and late of October. The study of number of leaves per m^2 in various treatments of N shows that N1 treatment in late May and middle of September, middle and late of October and N2 treatment in late of June, middle and late August led to the most number of leaves per m^2. In addition it was observable that the number of leaves per m^2 has reduced by increasing the amount of N and this is noticeable at the end of sampling (middle of October).

In addition the study of the process of leaves' number indicated that the least number of leaves was related to N2 treatment in late May, middle of June and also N4 treatment in the middle and late August, middle of September, middle and late of October. Therefore, it can be said that among various N treatments, the number of leaves per m2 has reduced extremely after an enhancement in aforementioned stages. The results of data variance analysis showed that variety treatment had significant effect on the number of leaves per m^2 in 1% in the late of June, middle and late of August, middle of September, middle and late October.

The study on the number of leaves per m^2 indicated that V1 variety caused the most number of leaves in the late of May, middle and late of August, and V2 led to the most number in the late of June, V3 in the middle of June and September and V4 in the middle and late of September. While the least number of leaves was related to V3 in the late of May, V2 in the middle of June, and September and middle and late of October and also V4 caused the least number of leaves in the late of June, middle and late of August.

Regarding table of variance analysis about number of leaves per m^2 in methanol treatments, methanol had significant effect on number of leaves per m^2 in 5% level in middle of June and September; and also it had significant effect in 1% level in the late June and middle of September and middle and late of October.

The study of process of number of leaves also indicated that the rising slope of leaves' number was highly intensive in M3 in the late of June till middle of August in comparison with M2 and M1. The leaves' number per m^2 had relatively similar processes in various treatments of methanol, but after the middle of August, the falling slope of leaves' number in M1 treatment was more significant than other treatments.

According to the results of data variance analysis table about interaction effects of treatments, the feature of number of leaves per m^2 was affected by interaction effect of N and variety in 1% level in the middle of August and middle and late of October.

The interaction effect of N and methanol had significant effect on number of leaves per m^2 in 1% during late of the August, middle of September and middle and late of October. Eventually, according to the data variance analysis results, the interaction effect of N, variety and methanol had significant effect on number of leaves per m^2 in 1% in the late of August, middle of September and middle and late of October.

Interaction effect of N, variety and methanol in the late of August showed that N1V1M1 led to the most number of leaves per m^2 (274.50) and was classified in the group a; in addition N4V4M1 (229.37) and N3V4M1 both led to the least number of leaves per m^2 and grouped in group x. Regarding the results of interaction effect of N, variety and methanol in the middle of September indicated that N2V4M3 led to the most number of leaves per m^2 in comparison with the other treatments, and this treatment was grouped in group a; moreover, N4V2M2 caused the least number of leaves.

The number of falling leaves per m^2

Regarding the results of variance analysis, N had not significant effect on the number of falling leaves per m^2 in aforementioned dates in 1 and 5% level.

The study on the number of falling leaves per m^2 in various treatments of N showed that N4 caused the most number of falling leaves per m^2 in under studied dates. The least number of falling leaves per m^2 was related to N2. The results of data variance analysis showed that variety treatment had significant effect on the number of falling leaves per m^2 in 1% level during the middle and late of the June, middle and late of the August and middle of September and middle and late of October. The study on the number of falling leaves per m^2 indicated that the number of leaves in variety of V1 was significantly more than other varieties and had the most number of leaves in the middle of October. While V4 had the least number of falling leaves per m^2 and has allocated the least number of falling leaves in aforementioned date among other varieties.

According to the table of variance analysis about methanol treatment, methanol had significant effect on the number of falling leaves in 1% level during middle and late of June, middle and late of August, middle of September and middle and late of October. The number of falling leaves showed that rising slope of falling leaves is more intensive in the middle of June till the middle of October in M1 treatment in comparison with M2 and M3. The process of number of falling leaves is relatively similar among various treatments of methanol. In the middle of October, M1 caused the most number of falling leaves per m^2.

According to the results of data variance analysis on interaction effects' treatments, the number of falling leaves was affected by interaction effect of N and variety in 1% level in the middle and late of June, middle and late of August, middle of September and middle and late of October.

Interaction effects of N and methanol on the number of falling leaves per m2 in the middle and late June, middle and late of August, middle of September and middle and late of October showed that N4M1 and N2M2 have allocated the most and the least number of falling leaves. In fact, the results showed that interaction effect of methanol and variety was significant in 1% in middle and late of June, middle and late of August, middle of September and middle and late of October.

The interaction effects of variety and methanol showed that V1M2 and V2M1 led to the most number of falling leaves and V4M2 and V4M3 have allocated the last rank.

Finally, according to the data variance analysis, interaction effect of N, variety and methanol was significant on the number of falling leaves in 1% level during middle and late of June, middle and late of August, middle of September and middle and late of October.

DISCUSSION

McLaren (1984) reported that transferring materials in stored roots and aerial organs of *Beta vulgaris* happen about 80 days after germination. Last *et al* (1983) reported that the ratio of root dry matter by total dry matter was increasing during growth period and it was affected by N fertilizer and irrigation. The experiments of these researchers in the late May showed that 20% of dry material was in the roots, but in harvesting time, this amount reached to 70%. Generally, consumption of N at the end of growth season, reduced allocated dry material till 6%. In an experiment that studied the effect of sources and N fertilizer amount on yellow leaved, it was determined that the amount of N fertilizer was effective on all of the features and by increasing fertilizer amount, quantitative characters (such as leaf area index) and qualitative characters decreased (Gohari and Jalilian, 1995). Another experiment in Karaj showed that enhancement of N amount in the soil, increased leaf surface index (Gohari, 1996).

If leaf area developed for absorbing solar radiation, more production of aerial organs for more sucrose synthesis is not useful (Anderson *et al.,* 1988). N can increase the size and number of leaves as well as their color; in addition, enhancement of N consumption can increase leaf area (Gohari, 1994).

If there was extreme lack of N, root and leaf growth decreases rapidly, but whenever this shortage was not so intensive, leaf growth decreases more than root growth. This indicates that if N storage is limited, stored sugar first will be used by root before leaves. In such condition, existed nitrate in the roots dwindles apparently, therefore root growth increases in comparison with leaf growth. Contrariwise, if N amount was sufficient, the most amount of N goes to young leaves and leaves grow more quickly than root; in fact, excess sugar and N intensify the leaves growth (Khodadadian, 1992).

Use of N fertilizer increases the growth of aerial organs, while whenever N is not available, plant will distribute materials to provide the growth of stored root rather than increase the number of aerial organs (Webb *et al.,* 1997). Managing soil N is a key for making a balance between crops' quality and quantity (Hauck, 1984). Therefore, it seems that careful management of N (timing and determining proper amount) plays important role in the pattern of transferring materials (Webb *et al.,* 1997).

Another study showed that aerial organs of *Beta vulgaris* contain 100-150kg N per hectare (Olsson and Bramstrop, 1994). Methanol increases the pressure of edema, sugar content and edema of cells in the leave that is useful for growth and development of the leaves (Zbiec *et al.,* 2003). This organic material can delay leaves aging and maintain their freshness through its effects on those stimulus that produce ethylene (Satler *et al.,* 1980).

Nanomura and Benson (1992) concluded that methanol spraying on aerial organs increases plant growth significantly in dry and warm regions. They observed that methanol spraying increases plant's turgidity and prevents leaves' dejection specifically in warm regions. The researchers attributed the growth enhancement to the role of methanol as a carbonic nutritional material (Fall and Benson, 1996).

Some studies indicated that application of alcohols delays leaves aging process among oat and clove; and this probably is because of prevention of ethylene in leaves' tissues among these plants (Heins, 1980; Saltveit, 1989).

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