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Effect of Foliar Spraying by Methanol on Growth of Common Bean and Snap Bean in Rasht, North of Iran

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Abstract: An experiment was conducted to evaluate the effects methanol spraying on growth of common bean and snap bean in Rasht, North of Iran. This experiment was done as a randomized complete block design for split-plot in three replications. The main-plot factor was variety in tow levels (common bean and snap bean) and the sub-plot factor, i.e., methanol use was considered at five levels (0, 10, 20, 30 and 40% methanol concentration). Results showed that maximum plant height, pod length, number of seeds per pod, number of pods formed per plant, number of ripe pods per plant and number of seeds per plant were in snap bean variety ($p<0.01$). Also, effect spraying methanol on number of seeds per pod, number of ripe pods per plant and number of seeds per plant were significant ($p<0.01$) that maximum average of number of seeds per pod (M = 8.5), number of ripe pods per plant (M = 7.8) and number of seeds per plant (M = 101.83) were in treatment of 40% methanol concentration and maximum plant height (M = 42.28 cm) was in 10% methanol concentration.

Key words: Spraying methanol, common bean, snap bean, number of pods, number of seeds, Iran

INTRODUCTION

Beans are edible seeds that belong to the legume family. Ripe and dry seeds of beans have high food value. Beans are sources rich of protein (18-32%) that these are grown in field extensively of world (Hosseini, 2008). Photosynthesis is the sub-stantial process for the production of organic matter in plants. Usually, the amount of the produced dry matter has a direct relationship with the photosynthesis efficiency of the plant and also the way in which CO_2 fixation occurs in crops. Therefore, the acceleration of the photosynthesis rate could be useful for increasing the capacity of producing crops.

Today in order to achieve this goal, compounds such as methanol, ethanol, propanol and butanol are used (Ramirez *et al*., 2006).

One of the main advantages of these compounds is their preventing and reducing the effects of stresses induced due to their photorespiration which ultimately results in increasing the production of organic matter in a plant along with increasing its growth and yield (Nonomura and Benson, 1992). Some of the methanol is oxidized in the presence of light (Galbally and Kirstine, 2002) and infuses more water and CO_2 to the plant which is accompanied by increased CO_2 concentration in leaves and causes the photosynthesis to accelerate (Li *et al*., 1995; Kotzabasis *et al*., 1999). Mirakhori *et al*. (2010a) reported that methanol application on red bean was effected on seeds yield, number of pods per plant, number of seeds per plant, number of stems per plant, total biomass 100 seeds weight and protein percent. In addition, result of those showed that maximum averages were in 20-25% methanol concentration.

Results a research conducted by Vishekaei (2007) showed that spraying the aerial parts of peanut with a 20% methanol solution increased the leaf area index, crop growth rate, leaf area duration, pod growth rate, radiation use efficiency, pod and seed yields, 100 seeds weight, number of mature pods and the protein content of a peanut seed. Also, Mirakhori *et al*. (2010b) with study of methanol spraying on soybean reported that maximum yield, plant height, 1000-seeds weight, number of ripe pods, leaf area and biomass were in 14 and 21% methanol concentrations. Results of Khomami *et al*. (2008) showed that spraying 30% methanol concentration was increased pods yield, seeds yield, pods number and seed protein percent in peanut plant. Thus, the present research was also conducted with the purpose of studying the possibility of using methanol to increase the growth of common bean and snap bean in Rasht city in the North of Iran.

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MATERIALS AND METHODS

In order to study the effect of foliar spraying by methanol on growth of common bean and snap bean in the 2010 crop year, an experiment was conducted in the Faculty of Agriculture of the Islamic Azad University, Rasht branch located 15 km Rasht city in the North of Iran (situated at 37°15'N and 49°53'E). Based on the Koppen classification, this region has a very humid climate with warm summers. Soil test results revealed that the soil texture is of the clay-sandy type (49 clay, 37 sand and 14% silt) with the pH and EC values being 6.37 and 0.5 day S/m, respectively.

In addition to the before mentioned, the organic matters, absorbable potassium, absorbable phosphorus and nitrogen were 0.6%, 81, 5 ppm and 0.02% in soil, respectively. This experiment was done as a randomized complete block design for split-plot in three replications.

The main-plot factor was variety in tow levels (common bean and snap bean) and the sub-plot factor, i.e., methanol use was considered at five levels (0, 10-40% methanol). To each one of these methanol application practices, 2 g L^{-1} glycine and 1 g L^{-1} tetrahydrofolate were added as catalysts. Also to improve and increase the viscosity of methanol solution, 1 m L^{-1} tween 80 was used.

The experiment was conducted in 5×2.5 m plots. Also, distances between plots of each replication and between replications were 0.5 m and about 1 m, respectively. The distance between rows was 50 cm while the distance between every two plants on the rows was 20 cm. Common bean seeds used in this experiment were of the indigenous type and snap bean seeds were from modified type. Plot irrigation was done every 6 days and weeding was carried out both mechanically and manually. Methanol spraying was done twice during the growing season with 10 days intervals. The 1st spraying of the plants was done during early pod formation and continued until solution drops flowed on the plants.

The studied characteristics were plant height, pod length, number of seeds per pod, number of pods formed per plant, number of ripe pods per plant and number of seeds per plant. To calculate the plant height, 10 plants were randomly selected from each plot with the height of each plant measured and when these ten heights were averaged, the plants height at the time of harvest was obtained. Also, ten pods were randomly selected from each plot with the length of each pod measured. The average of ten obtained lengths gave the pods length at the time of harvest. In addition, ten pods were randomly selected from each plot and their seeds were counted. The average of ten counts gave the number of seeds per pod. When the plants reached the harvest stage, five plants from each plot were selected with their number of pods formed per plant, number of ripe pods per plant and number of seeds per plant. In order to do the analysis of variance and means comparison (Duncan test at the probability level of 5%) was used from MSTAT-C.

RESULTS AND DISCUSSION

Plant height: Result showed that effect of variety on plant height was significant at the probability level of 1% (Table 1) with the most plant height (M = 43.3 cm) in variety of snap bean (Table 2). In this study, the effect of methanol foliar spraying on the plant height was significant at the probability level of 1% (Table 1). Results from mean comparisons showed that the highest plant height (M = 42.28 cm) was that of the 10% methanol concentration (Table 2).

Interaction between the variety and methanol on bean height was significant at the probability level of 5% (Table 1) that maximum height average (48.83 cm) was in snap bean and 10% methanol concentration (Table 2). This result was similar with Mirakhori *et al.* (2009) regarding soybean that reported maximum plant height (67.9 cm) was in 7% methanol concentration. Also, Vishekaei (2007) reported that maximum peanut height was in treatment of 30% methanol concentration.

Pod length: In this study, result showed that there was significant difference ($p<0.01$) between varieties regarding pod length (Table 1) that maximum average (12.9 cm) was in variety of snap bean (Table 2). Effect of methanol and interaction between the variety and methanol on pod length was not significant (Table 1). Similar results were reported by Rajala *et al.* (1998) regarding C_3 plants.

Number of seeds per pod: Result showed that effect of variety on number of seeds per pod was significant at the probability level of 1% (Table 1) that maximum average (M = 7.69) was in snap bean (Table 2). Effect of methanol spraying on number of seeds per pod was significant at the probability level of 1% (Table 1). The maximum average of number of seeds per pod (M = 8.5) was in 40% methanol concentration (Table 2).

Interaction between the variety and methanol on number of seeds per pod was significant at the probability level of 1% (Table 1) that most average (M = 9.33) was in snap bean and 40% methanol concentration (Table 2). Similar result was reported by Vishekaei (2007) regarding peanut plant.

Table 1: Analysis of variance for the effects of methanol on growth of common bean and snap bean

		Mean squares					
Source of variation	df	Plant height	Pod length	No. of seeds per pod	No. of pods formed per plant	No. of ripe pods per plant	No. of seeds per plant
Blocks	2.0	3.110^{NS}	0.949^{NS}	0.009^{NS}	1.225^{NS}	0.081^{NS}	51.971^{NS}
Variety (C)	1.0	535.096**	138.245**	89.787**	243.675**	100.467**	41027.091**
Error	2.0	1.554	0.720	0.016	0.529	0.121	51.163
Methanol concentration (M)	4.0	125.451**	3.495^{NS}	24.223**	2.737^{NS}	11.865**	3356.752**
Variety x Methanol (MC)	4.0	15.827*	1.185^{NS}	6.057**	4.583*	4.452*	919.782**
Error	16.0	4.436	1.456	0.011	1.172	1.009	65.263
C.V. (%)	5.4	11.190	1.760	9.370	16.070	10.840	

^{NS}Non-significant, *significant at $p<0.05$ and **significant at $p<0.01$

Table 2: Mean comparison effect of methanol on growth of common bean and snap bean by Duncan's Multiple Range Test (DMRT)

Treatments	Plant height (cm)	Pod length (cm)	No. of seeds per pod	No. of pods formed per plant	No. of ripe pods per plant	No. of seeds per plant
Varieties						
C_1 (common bean)	34.81^{b}	8.63^{b}	4.23^{b}	8.70^{b}	4.42^{b}	37.54^{b}
C_2 (snap bean)	43.26^{a}	12.93^{a}	7.69^{a}	14.40^{a}	8.08^{a}	111.50^{a}
Methanol concentration						
M_1 (0)	31.15^{b}	10.20^{b}	4.00^{d}	10.35^{b}	4.20^{c}	46.44^{c}
M_2 (10%)	42.28^{a}	9.95^{b}	4.77^{c}	11.95^{a}	5.70^{bc}	59.51^{b}
M_3 (20%)	39.93^{a}	11.25^{ab}	4.80^{c}	11.80^{a}	6.30^{ab}	69.12^{b}
M_4 (30%)	39.67^{a}	10.68^{ab}	7.72^{b}	11.90^{a}	7.25^{ab}	95.71^{a}
M_5 (40%)	42.15^{a}	11.82^{a}	8.50^{a}	11.75^{a}	7.80^{a}	101.83^{a}
Variety x Methanol						
C_1M_1	28.73^{e}	7.63^{c}	1.67^{i}	8.20^{c}	2.80^{d}	13.72^{e}
C_1M_2	35.73^{cd}	7.57^{c}	3.53^{h}	9.80^{c}	5.10^{bc}	34.63^{d}
C_1M_3	36.53^{cd}	9.73^{bc}	1.60^{i}	7.90^{c}	3.70^{cd}	12.64^{e}
C_1M_4	34.53^{d}	8.27^{bc}	6.67^{e}	8.20^{c}	4.60^{bcd}	54.67^{c}
C_1M_5	38.53^{c}	9.97^{b}	7.67^{d}	9.40^{c}	5.90^{b}	72.07^{b}
C_2M_1	33.57^{d}	12.77^{a}	6.33^{f}	12.50^{b}	5.60^{b}	79.17^{b}
C_2M_2	48.83^{a}	12.33^{a}	6.00^{g}	14.10^{ab}	6.30^{b}	84.40^{b}
C_2M_3	43.33^{b}	12.77^{a}	8.00^{c}	15.79^{a}	8.90^{a}	125.60^{a}
C_2M_4	44.80^{ab}	13.10^{a}	8.77^{b}	15.60^{a}	9.90^{a}	136.76^{a}
C_2M_5	45.77^{a}	13.67^{a}	9.33^{a}	14.10^{ab}	9.70^{a}	131.60^{a}

In each column, means with the similar letters are not significantly different at 5% level of probability using DMRT

Number of pods formed per plant: Variance analysis shown in Table 1 showed that there was a significant difference between variety treatments in terms of number of pods formed per plant (with 99% confidence coefficients). The effect of variety showed that the maximum number of pods formed per plant (M = 14.4) was in snap bean which compared with the common bean treatment (Table 2). But there was no-significant difference between methanol treatments in terms of the number of pods formed per plant (Table 1). Results in Table 1 showed that there was a significant difference between interaction treatments with number of pods formed per plant ($p<0.05$).

Maximum number of pods formed (M = 15.6) was that of the snap bean with 30% methanol concentration treatment per plant (Table 2). Also, Mirakhori *et al.* (2010a) reported that effect of methanol foliar spraying on the number of pods per plant was significant regarding red bean that maximum number of pods per plant was in 25% methanol concentration treatment with average of 18.3 per plant. In addition, similar results were reported by Li *et al.* (1995) on soybean and Vishekaei (2007) regarding peanut.

Number of ripe pods per plant: Results from the variance analysis in Table 1 showed that there was a significant difference between common bean and snap bean regarding number of ripe pods per plant ($p<0.01$) that most number of ripe pods per plant (M = 8.1 plant^{-1}) was in snap bean (Table 2). Effect of methanol on number of ripe pods of bean was significant at the probability level of 1% (Table 1). Most number of ripe pods was in 40% methanol concentration treatment with average of 7.8 pods plant^{-1} (Table 2).

Interaction between variety and methanol on number of ripe pods was significant at the probability level of 5% (Table 1) that most average (9.9 pods plant^{-1}) was in snap bean with 30% methanol concentration (Table 2). These results were similar to Li *et al.* (1995) and Zbiec *et al.* (2003). Also, Vishekaei (2007) reported that most number of ripe pods in peanut was in 20% methanol concentration.

Number of seeds per plant: Results showed that there was a significant difference ($p<0.01$) between common bean and snap bean regarding number of seeds per plant

(Table 1) that maximum average (M = 111.5 seeds plant^{-1}) was in snap bean (Table 2). Effect of methanol spraying on number of seeds per plant was significant at the probability level of 1% (Table 1). Most average of number of seeds (101.83 seeds plant^{-1}) was in 40% methanol concentration (Table 2). Interaction between variety and methanol on number of seeds per plant was significant at the probability level of 1% (Table 1) that most average (136.76 seeds plant^{-1}) was in treatment of snap bean with 30% methanol concentration (Table 2). Mirakhori *et al.* (2010a) with methanol spraying on red bean plant reported that there was a significant difference between different treatments regarding number of seeds per plant. Those showed that the most number of seeds per plant was in treatment of 20% methanol concentration.

CONCLUSION

In general, maximum growth was in snap bean variety. Also, effect of methanol spraying showed that most average of number of seeds per pod, number of ripe pods per plant and number of seeds per plant were in treatment of 40% methanol concentration and most plant height was in 10% methanol concentration. Nonomura and Benson (1992) stated that applying methanol increases a plant's growth as a carbon resource and can increase its photosynthesis efficiency. Up to now, nitrogen, phosphorus and potassium fertilizers are commonly used for agricultural purposes and even recently, some microelements have also been taken into account but the increase of the plant's available CO_2 on the surface has not been practically considered which could be done by CO_2 injection at the greenhouse level. Usually, a major part of a plant's dry weight is made up of carbon therefore, using methanol as a carbon resource-increasing factor and photosynthesis efficiency could greatly affect crop growth and yield.

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