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Effect of Time and Foliar Spraying by Methanol on Growth and Yield of Cowpea (*Vigna unguiculata*)

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Abstract: An experiment was conducted to evaluate the effects of concentration time and spraying methanol on growth and yield of cowpea of (*Vigna unguiculata*) in Rasht, north of Iran. This study was done as a two-factor factorial experiment in a basic plan of randomized complete blocks in three replications. The first factor was the time of methanol application in three levels [spraying in the morning (8:00-10:00 a.m.), at noon (13:00-15:00 p.m.) and in the afternoon (17:00-19:00 p.m.)] and the second factor, i.e. methanol use was considered at four levels [0, 10, 20 and 30% methanol]. Results showed that concentration and time spraying methanol affected on pod and seed yield of cowpea. Among methanol concentration treatments, maximum pod and seed yield values of 1743.81 and 930.54kg/ha were recorded for the 20% and 30% methanol treatments, respectively. Furthermore, the spraying in afternoon resulted in the highest pod and seed yields amounting to 1649.56 and 902.42kg/ha, respectively.

Key word: Cowpea % Methanol % Concentration and Time % Seed yield % Pod yield

INTRODUCTION

Cowpea is a weedy annual plant with a low growth rate and has, to some extent, a running bush. It is of the legume family, *Vigna* genus whose studied species here is *unguiculata*. Cowpea originated from Africa and is currently cultivated and consumed in many countries including Iran. The production of cowpea throughout the world in recent years has been estimated to be 2.27 million tons with a cultivation area of 7.7 million hectares.

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 and amino acids like glycine, glutamate and asparate are used. 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 [1]. In an inactive way and through a simple emission from the membrane, methanol, ethanol and other alcohols are absorbed by plant cells. Here, the absorption rate directly depends on alcohol concentration. Also, the actual amount of absorbed methanol varies depending on the type of plant tissues [2]. Some of the methanol is oxidized in the presence of light [3] and infuses more water and CO_2 to the plant, which is accompanied by increasing CO_2 concentration in leaves and causes the photosynthesis to accelerate [4, 5]. Also, methanol's periodic application with certain intervals causes the metabolic rate of respiration of a plant to increase. Moreover, a plant's growth rate depends on its efficiency and the metabolic rate of respiration [6]. In general, methanol spraying increased the respiration rate and the efficiency of the carbon resulting from respiration [7-9].

Zbiec *et al.* [10] reported that methanol spraying was accompanied by increasing carbon accumulation in the studied plants and stopped their photorespiration. They also reported that using methanol increased the growth of different plants such as soybean, sugar beet, turnip, while application of 20%-30% methanol concentration led to a significant increase in seed yield and reduced their water requirement. Li *et al.* [4] reported that methanol had a

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positive effect of seed yield, seed weight and number of pods per plant in soybean. Also, Safarzadeh Vishekaei [1] showed that spraying the aerial parts of peanut with 20% methanol solution increased leaf area index (LAI), crop growth rate (CGR), leaf area duration (LAD), pod growth rate (PGR), radiation use efficiency, pod and seed yields, 100-seeds weight, number of mature pods and protein content in peanut. Mirakhori *et al.* [11] reported that methanol spraying was accompanied with increasing yield, height, 1000-seed weight, pod numbers, leaf area and biomass in soybean. Thus, the present study was also conducted with the purpose of studying the possibility of using methanol to increase the growth and yield of cowpea in Rasht City in the north of Iran.

MATERIAL AND METHODS

In order to study the effect of time and foliar spraying of methanol on growth and yield of cowpea(*Vigna unguiculata*) during 2009 growing season, an experiment was conducted in the Faculty of Agriculture , Islamic Azad University (IAU), Rasht Branch located 15km 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. Average annual precipitation level of the region is approximately 1250 mm and reaches about 430 mm during the cultivation season. Soil test results revealed that the soil texture is of the sandy-loam type (18% clay, 69% sand and 13% silt) with pH and EC values being 6.37 and 0.5dS/m, respectively. In addition to the above-mentioned, the organic matters of the region's soil are potassium, phosphorus and nitrogen which are given in Table 1.

This study was done as a two-factor factorial experiment in a basic plan of randomized complete blocks in three replications. The first factor was the time of methanol application in three levels [spraying in the morning (8:00-10:00 a.m.), at noon (13:00-15:00 p.m.) and in the afternoon (17:00-19:00 p.m.)] and the second factor, i.e. methanol use was considered at four levels [0, 10, 20 and 30% methanol]. To each one of these methanol application practices, 2g/l glycine and 1g/l tetrahydrofolate were added as catalysts. Also, to improve and increase the viscosity of methanol solution, 1g/l tween 80 was used. The experiment was conducted in 4×2 m plots, each of which having four cultivation rows. Also, distances between plots of each replication and between replications were 0.5m and about 1m, respectively. The distance between rows was 50cm, while the distance between every two plants on the rows was 20 cm. cowpea seeds used in this experiment were of the indigenous type. Plot irrigation was done every six days and weeding was carried out both mechanically and manually. Methanol spraying was done twice during the growing season with 10-day intervals. The first spraying of the plants was done during early pod formation and continued until solution drops flowed on the plants.

The studied characteristics were pod yield in the unit of surface, seed yield in the unit of surface, number of pods per m^2, 100-seeds weight, number of seeds per pod, harvest index (HI), pod length and plant height at the time of harvesting. To calculate the 100-seeds weight, seeds from mature pods of each plot were weighed by a scale. Also, ten pods were randomly selected from each plat and their seeds were counted. The average of ten counts gave the number of seeds per pod. Then, 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 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. When the plants reached the harvest stage, five plants from each plot were selected with their biological yield and economic yield (pods) parts separately dried in the oven and then weighed. Weights obtained from each plant were put in the following formula and thus, the harvest index (HI) was calculated. In order to do the variance analysis and compare the mean values, SPSS 16 software was used.

Harvest Index = Economic Yield (Pods) / Biological Yield (Total) × 100

RESULTS AND DISCUSSION

In this study, the effect of methanol concentration and spraying time on cowpea, plant height was not significant (Table 2). Since the first spraying was done

Table 1: Results of soil test

Sand (%)	Silt (%)	Clay (%)	Organic Material (%)	Nitrogen (%)	Absorbable Potassium (ppm)	Absorbable Phosphorus (ppm)	pH	EC (dS/m)
69	13	18	0.6	0.02	81	5	6.37	0.5

Table 2: Variance analysis for effects of density and time of methanol application on growth and yield of Cowpea (*Vigna unguiculata*)

		MS							
SOV	d.f	Pod length	Plant height	100-seed weight	Pod yield per m^2	Number of seeds per pod	Number of pods per m^2	Seed yield per m^2	Harvest index
Blocks	2	2.61*	1150.52**	5.47^{ns}	5681.4**	1.19^{ns}	11003.11**	1656.7**	9.49^{ns}
Methanol concentration	3	0.28^{ns}	96.29^{ns}	2.5^{ns}	1700.32**	0.52^{ns}	1693.14**	465.99**	260.52**
Time of application	2	0.7^{ns}	56.77^{ns}	5.97^{ns}	857.55**	0.74^{ns}	450.19^{ns}	303.48**	146.27**
M× Time	6	0.53^{ns}	62.62^{ns}	4.14^{ns}	121.67^{ns}	0.86^{ns}	344.12^{ns}	6.98^{ns}	21.76^{ns}
Error	22	0.48	44.01	1.92	103.81	0.42	286.62	37.25	24.77
C.V (%)	4.12	9.63	10.2	6.45	4.13	8.15	7.16	15.2	

^{ns} Non significant, *significant at P<0.05 and **significant at P<0.01

Table 3: The mean analogy by Duncan's multiple range test

Treatments	Pod length (cm)	Plant height (cm)	100-seed weight (g)	Pod yield (g/m^2)	Number of seed / pod	Number of pod / m^2	Seed yield (g/m^2)	Harvest index (%)
Methanol concentration								
0	16.57a	64.88b	13.78a	141.70c	15.68a	194.22c	80.32b	26.31c
10%	16.95a	68.66ab	12.96a	153.58b	15.54a	198.22bc	78.03b	30.67bc
20%	16.95a	69.11ab	13.41a	174.38a	16.03a	214.67ab	89.50a	38.66a
30%	16.84a	72.88a	14.20a	161.66b	16.01a	223.33a	93.05a	35.23ab
Time of application								
Morning (8-10 am)	16.83a	71.16a	13.84ab	148.49b	15.89a	200.83a	80.18b	29.68b
Midday (1-3 pm)	17.07a	68.66a	12.79b	160.05a	16.02a	209.25a	85.25ab	31.94b
Afternoon (5-7 pm)	16.59a	66.83a	14.14a	164.96a	15.54a	212.75a	90.24a	36.53a

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

during early pod formation stages and because cowpea has a limited growth, more growth could not be expected. So this finding contradicts those obtained by Mirrakhori *et al.* [12] on soybean. The effect of methanol concentration and spraying time on pod length of cowpea was not significant (Table 2). With consideration of the fact that this trait is more genetically affected and less influenced by the environment, this result seemed logical.

The Effect of methanol concentration on number of pods per m^2 was significant at the probability level of 1% (Table 2) that the largest number of pods per m^2 (M=223.33) was in treatment of 30% methanol (Table 3). These results are in accordance with findings of Li *et al.* [4] and Safarzadeh Vishekaei [1], they reported that methanol spraying had a positive effect on the number of pods in soybean and peanut, respectively. On contrary, in this study, the effect of the time of methanol spraying on the number of pods was not significant (Table 2).

Methanol concentration, spraying time and the interaction between time and spraying concentration didn't have a significant effect on number of seeds per pod (Table 2). Therefore, this result is not consistent with Sunderman and Sweeney [13].

In this study, the time and concentration of spraying methanol on the leaves did not have any significant effect on 100-seeds weight of cowpea (Table 2) which was consistent with the results of Rajala *et al.* [14] who studied the effect of methanol on spring cereals, peas and summer forage rape seed and also those of Sunderman and Sweeney [13] who studied this effect on soybean. Furthermore, the 100-seeds weight is a genetic trait and is less affected in different experiments. Moreover, Mirrakhori *et al.* [12] and Li *et al.* [4] concluded that methanol spraying had a positive effect on 100-seeds weight of soybean.

The effect of the time and concentration of methanol spraying on the pod yield of cowpea was significant at the probability level of 1% (Table 2). Results from mean comparisons showed that the highest pod yield (M=174.38g/m^2) was that of the 20% methanol concentration. Also, the highest pod yield (M=164.96g/m^2) was that of the afternoon spraying (Table 3). Mirrakhori *et al.* [12] and Safarzadeh Vishekaei [1] reported that methanol increased pod yield in peanut and soybean, respectively.

The effect of the time and concentration of methanol spraying on the seed yield of cowpea was significant at the probability level of 1% (Table 2). Results from mean comparisons showed that the highest seed yield (M=93.05g/m^2) was that of the 30% methanol concentration. Also, the highest seeds yield (M=90.24g/m^2) was that of the afternoon spraying (Table 3). Results from the present study in terms of the effect of methanol on the seed yield were consistent with those of Mirrakhori *et al.* [12], Li *et al.* [4] and Safarzadeh Vishekaei [1], while Rajala *et al.* [14], Sunderman and Sweeney [13] and Murali *et al.* [2] obtained contradictory results compared with those of this study.

The effect of the time and concentration of methanol spraying on harvest index (HI) was significant at probability levels of 1% (Table 2). It seemed that methanol mostly affected the allocation of most of the dry matter to the reproductive organs which of course requires more research. The harvest index gave the best results at 20% methanol spraying (M=38.66%). Mirrakhori *et al.* [12] and Rajala *et al.* [14] stated that methanol did not have any effect on the harvest index. In this study, the mean analogy in Table 3 showed that spraying in time of afternoon resulted to the highest harvest index (M=36.53%). The interaction between methanol concentration and spraying time on harvest index of cowpea was not significant (Table 2).

CONCLUSION

In general, results of the present study suggested that methanol concentration and spraying time affected on pod and seed yield of cowpea. Among methanol concentration treatments, the maximum pod and seed yield values of 1743.81 and 930.54kg/ha were recorded at 20% and 30% methanol treatments, respectively. Furthermore, spraying at afternoon resulted in the highest pod and seed yields amounting to 1649.56 and 902.42kg/ha, respectively (Fig. 1-4). Nonomura and Benson [15] stated that applying methanol increased plant growth as a carbon resource and increased 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 dry weight is made up of carbon; therefore, using methanol as a carbon resource-increasing factor

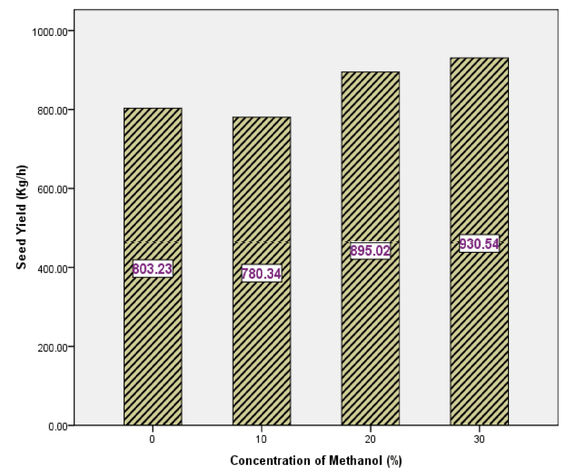

Fig. 1: Effect of methanol concentration on seed yield (kg/ha)

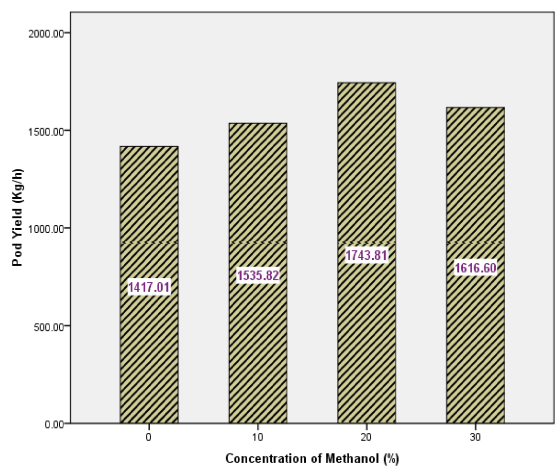

Fig. 2: Effect of methanol concentration on pod yield (kg/ha)

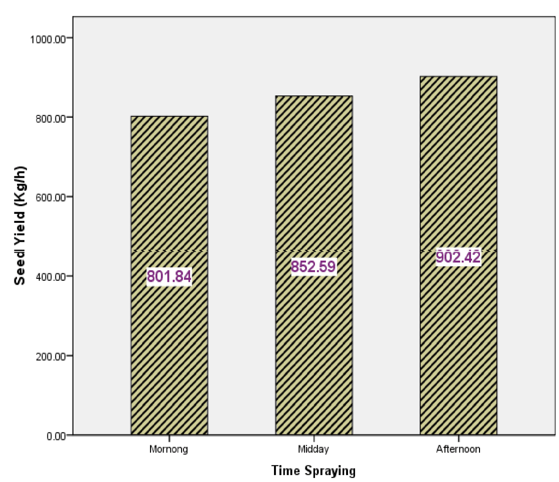

Fig. 3: Effect of time spraying methanol on seed yield (kg/ha)

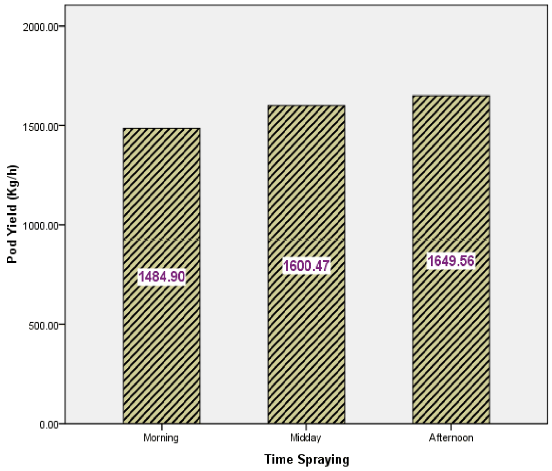

Fig. 4: Effect of time spraying methanol on pod yield (kg/ha)

and photosynthesis efficiency could greatly affect crop growth and yield. With the above-said taken into account, using methanol spraying is of great significance. If we study the applied aspect of using methanol, may be with its price and high consumption rate at a vast field level taken into consideration, its use would become doubtable. However, based on the above-mentioned issues and that methanol can provide carbon which is among the necessary and high-consumption elements required by a plant, it could be considered as a fertilizer. Just like many countries, where fertilizers are subsidized, the same measure can be taken regarding methanol. Of course, this would be achievable only if the usefulness of its application for different crops is proved quite well which would require doing more experiments in the future.

REFERENCES

1. Safarzadeh Vishekaei, M.N., 2007. Effect of methanol on growth and yield of peanut (*Arachis hypogaea* L.), Ph.D Thesis, Islamic Azad University, Sciences and Researches Branch, Tehran, Iran, (In Persian). pp: 232.
2. Murali, N.S., W. Meskuntavon and T.M. Aye, 1994. Effect of methanol on the growth of field crops under water stress on Bangkok plain. Suranaree J. Sci. Technol., 2: 1.
3. Galbally, E. and W. Kirstine, 2002. The production of methanol by flowering plants and the global cycle of methanol. J. Atmos. Chem., 43(3): 195-229.
4. Li, Y., J. Gupta and A.K. Siyumbano, 1995. Effect of methanol on soybean photosynthesis and chlorophyll. J. Plant Nutr., 18: 1875-1880.
5. Kotzabasis, K., A. Hatziathanasiou, M.V. Bengoa-Ruigomez, M. Kentouri and P. Divanach, 1999. Methanol as alternative carbon source for quicker efficient production of the microalgae Chlorella minutissima: role of the concentration and frequency of administration. J . Biotechnol., 70: 357-362.
6. Hanson, A.D. and S. Roje, 2001. One-carbon metabolism in higher plants. Annu. Rev. Plant Physiol. Plant Mol. Biol., 52: 119-137.
7. Hemming, D. and R. Criddle, 1995. Effects of methanol on plant respiration. J. Plant Physiol., 146: 193-198.
8. Nemecek-Marshall, M., R.C. MacDonald, J.J. Franzen, C.L. Wojciechowski and R. Fall, 1995. Methanol emission from leaves: enzymatic detection of gas-phase methanol and relation of methanol fluxes to stomatal conductance and leaf development. Plant Physiol., 108: 1359-1368.
9. Fall, R. and A.A. Benson, 1996. Leaf methanol-the simplest natural product from plants. Trends Plant Sci., 1: 296-301.
10. Zbiec, I., S. Karczmarczyk and C. Podsiad»o, 2003. Response of some cultivated plants to methanol as compared to supplemental irrigation. Elec. J. Polish. Agric. Univ., Agronomy, 6(1): 1-7.
11. Mirakhori, M., F. Paknejad, M.R. Ardakani, F. Moradi, P. Nazeri and M. Nasri, 2010. Effect of methanol spraying on yield and yield components of soybean (*Glycine max* L.). J. Agroecol., 2(2): 236-244.
12. Mirakhori, M., F. Paknejad, F. Moradi, M.R. Ardakani, H. Zahedi and P. Nazeri, 2009. Effect of drought stress and methanol on yield and yield components of Soybean Max Am. J. Biochem. and Biotech, 5(4): 162-169.
13. Sunderman, H.D. and D.W. Sweeney, 1997. Soybean response to foliar applied methanol in humid and semiarid environments. J. Production Agric., 10(3): 415-418.
14. Rajala, A., J. Karkkainen, J. Peltonen and P. Peltonen-Sainio, 1998. Foliar applications of alcohols failed to enhance growth and yield of C_3 crops. Industrial Crops and Products, 7: 129-137.
15. Nonomura, A.M. and A.A. Benson, 1992. The path of carbon in photosynthesis: improved crop yields with methanol. Proc. Natl. Acad. Sci. U.S.A., 89: 9794-9798.