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Research Article

Evaluation of Methanol Spraying on Yield Components of Triple Intercropping of Roselle, Peanut and Aloe Vera

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ABSTRACT

Today, intercropping is commonly used in many tropical parts of the world particularly by small-scale traditional farmers. Foliar applications of methanol in various plants have been reported to improve yield and reduce stress mainly via enhancing CO2 fixation rates. Roselle (*Hibiscus sabdariffa*) belongs to the family Malvaceae. The field experiment was laid out split plot with randomized complete block design with three replications. Treatments included methanol foliar application (10, 20 and 30 volumetric percentage) and intercropping (sole peanut, sole roselle, sole Aloe vera, 50% roselle + 25% peanut + 25% Aloe vera, 100% roselle + 50% peanut + 50% Aloe vera, 40% roselle + 30% peanut + 30% Aloe vera, 100% roselle + 25% peanut + 75% Aloe vera, 60% roselle + 20% peanut + 20% Aloe vera, 100% roselle + 75% peanut + 25% Aloe vera). Analysis of variance showed that the effect of Methanol on all characteristics was significant. The maximum of Peanut biological yield, boll wet weight and roselle biological yield of treatments 30 % was obtained. The minimum of Peanut biological yield, boll wet weight and roselle biological yield of treatments 10% was obtained. Research in different countries reveals that in addition to increasing the ecological and economic diversity, intercropping brings an increase in production or yield benefits, more efficient use of water resources, land, nutrients and labors, reduction in problems caused by pests, diseases and weeds.

Key words: Biological yield, Intercropping, Methanol

INTRODUCTION

Traditional agriculture, as practiced through the centuries all around the world, has always included different forms of intercropping. In fact, many crops have been grown in association with one another for hundred years and crop mixtures probably represent some of the first farming systems practiced (Plucknett and Smith, 1986). Various types of intercropping were known and presumably employed in ancient Greece about 300 B.C. Theophrastus, among the greatest early Greek philosophers and natural scientists, notes that wheat, barley, and certain pulses could be planted at various times during the growing season often integrated with vines and olives, indicating knowledge of the use of intercropping (Papanastasis *et al*., 2004). Today, intercropping is commonly used in many tropical parts of the world particularly by small-scale traditional farmers (Altieri, 1991). Traditional multiple cropping systems are estimated to still provide as much as 15-20% of the world's food supply (Altieri, 1999). Intercropping is one of the most common practices used in sustainable agricultural systems which have an important role in increasing the productivity and stability of yield in order to improve resource utilization and environmental factors (Alizadeh *et al*., 2010). Intercropping legumes and non-legumes is an agricultural practice of cultivating two or more crops in the same place of land at the same time which is commonly practiced in many parts of the world in order to increase the productivity per unit area of the land (Bhupinder *et al*., 2003). Intercropping also referred to as mixed cropping or polyculture, is the agricultural practice of cultivating two or more crops in the same space at the same time (Andrews and Kassam, 1976). The component crops of an intercropping system do not necessarily have to be sown at the same time nor they have to be harvested at the same time, but they should be grown simultaneously for a great part of their growth periods. In intercropping, there is normally one main crop and one or more added crop(s), with the main crop being of primary importance for economic or food production reasons. The two or more crops in an intercrop normally

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are from different species and different plant families, or less commonly they may be simply different varieties or cultivars of the same crop, such as mixing two or more kinds of wheat seed in the same field. The most common advantage of intercropping is to produce a greater yield on a given piece of land by achieving more efficient use of the available growth resources that would otherwise not be utilized by each single crop grown alone. There are many different kinds of species that can be used for intercropping such as annuals, e.g. cereals and legumes, perennials, including shrubs and trees, or a mixture of the two (annuals and perennials). In the case of shrubs and trees the term mostly used is agroforestry (Anil *et al*., 1998). The crops are not necessarily sown at the same time and their harvest time may be quite different, but they are usually simultaneously grown for significant growing periods (Willey, 1990). Research in different countries reveals that in addition to increasing the ecological and economic diversity, intercropping brings an increase in production or yield benefits, more efficient use of water resources, land, nutrients and labors, reduction in problems caused by pests, diseases and weeds (Awal *et al*., 2006). Regarding to increasing growth of the world population, demolition and overthrown of ecological balance of the systems, it is of a great importance to increase agricultural products and environmental preservation. Variety of methods have been developed and used to achieve high production rates including technological and genetic methods, and chemical fertilizers and herbicides; but use of such methodologies has helped us only partly in order to meet our needs in the area so food production has to be considered along with environmental conservation (Awal *et al*., 2006). Intercropping promotes diversification and allows greater flexibility in adjusting to short and long terms changes in the production and marketing situations. Intercropping provides better weed control and reduces pest and disease incidence (Finney, 1990). Intercropping may also lead to increased production per unit area per unit time without affecting the yield of main crop to a greater extent. When legumes are used as intercrops, they provide the beneficial effect on soil fertility by fixing atmospheric nitrogen. Best utilization of nutrients, moisture, space and solar energy can be derived through mixed intercropping system. Roselle (*Hibiscus sabdariffa*) belongs to the family Malvaceae. It is an erect, mostly branched, annual, herbaceous sub shrub that grows mainly in warm humid tropical and subtropical climates. Vernacular names in English speaking regions are rozelle, sorrel, and red sorrel while in Arabic it is known as karkade; in French, osielle rouge or oseille de Guinée. In Senegal Bisap is commonly used (Morton, 1987). The stems of roselle are reddish in color, the leaves are dark green to red, and flowers are red to yellow with dark centers (Morton, 1987). Various parts of the plant including seeds, leaves, calyx and roots are used in food production. The calyces, which contain flavonoids, riboflavin, ascorbic acid, calcium, and iron, are used as a natural food dye (Morton, 1987). Additionally, the seeds of roselle are rich in protein and have been ground into a meal for human consumption in Africa. In many countries, especially in Africa, extract from the calyces is used for making hot tea or cold drink (McKay, 2009). Furthermore, Roselle calyces have been used in folk medicines for many years and have been proven effective in tolower blood pressure patients with hypertension and type II diabetes. The medicinal aspects of roselle were further proven to exhibit a wide range of applications including, as a mild laxative and diuretic, for digestive and kidney functions, and treating sores and wounds (Morton, 1987). The antimicrobial properties of roselle were attributed to the presence of an abundance of secondary metabolites including a wide range of phenolic compounds (Ali *et al*., 2005). Additionally, some of these naturally occurring phenolic compounds have shown anti-carcinogenic, anti-hypertensive, anti-microbial, anti-mutagenic, anti-oxidative, and anti-inflammatory properties (Mckay *et al*., 2009). Phenolic compounds are also known to have antioxidant activity and anti-mutagenic properties by binding to free radicals through their chemical structure (Visioli *et al*., 1998). Peanut (*Arachishypogaea* L.) is an important grain legume in Thailand. The production of the crop is mainly concentrated in upland area under rain-fed conditions where the amount and distribution of rainfall are relatively poor (Jogloy *et al*., 1996; Vorasoot *et al*., 1985). Unpredictable and intermittent periods of water deficit commonly occur during growing season (Vorasoot *et al*., 1985). Aloe vera is a succulent CAM plant recently domesticated in Mexico. This plant is different from other CAM species because it is a native of the semitropical regions of South Africa (Cowling, 1982). Thus, the behavior of such plants cultivated under a semiarid environment may be different from that of the native species. The stomata of these plants open at night and close during the day, and as a consequence, all exogenous gas exchange occurs at night. The CO2 is fixed by the enzyme phosphoenol pyruvate carboxilase (PEP Case) producing malic acid that is decarboxylated during the day, generating CO2 that is refixed photosynthetically (Bastide *et al*., 1993). Methanol spray is introduced as a suitable method which can increase CO2 assimilation (Hossinzadeh *et al*., 2012). Foliar applications of methanol in various plants have been reported to improve yield and reduce stress (Ramirez *et al*, 2006) mainly via enhancing CO2 fixation rates (Nadali *et al.*, 2010). It has been stated that foliar utilization of methanol, as a source of carbon, increase the growth and yield of different plant species (Nadali *et al*., 2010).Methanol induced changes in critical compounds like jasmonate may be responsible for the observed results. It has been reported that the various metabolic pathways related to plant growth, development and defense mechanisms such as activation of genes involved in the jasmonic acid biosynthesis were affected by the exoge-nously applied methanol (Ramadan and Omran, 2005).

MATERIALS AND METHODS

Location of experiment

The experiment was conducted at the zahak which is situated between 31° North latitude and 61° East longitude.

Composite soil sampling

Composite soil sampling was made in the experimental area before the imposition of treatments and was analyzed for physical and chemical characteristics.

Field experiment

The field experiment was laid out split plot with randomized complete block design with three replications.

Treatments

Treatments included methanol foliar application (10, 20 and 30 volumetric percentage) and intercropping (sole peanut, sole roselle, sole Aloe vera, 50%roselle + 25% peanut + 25%Aloe vera, 100% roselle + 50% peanut + 50% Aloe vera, 40% roselle + 30% peanut + 30% Aloe vera, 100% roselle + 25% peanut + 75% Aloe vera, 60% roselle + 20% peanut + 20% Aloe vera,100% roselle + 75% peanut + 25% Aloe vera).

Harvest plants

Harvested plants were dried in 25°C and under shadow and air flow then grains were separated from their remains by threshing.

Data collect

Data collected were subjected to statistical analysis by using a computer program SAS. Least Significant Difference test (LSD) at 5 % probability level was applied to compare the differences among treatments` means.

RESULTS AND DISCUSSION

Peanut biological yield

Analysis of variance showed that the effect of Methanol on peanut biological yield was significant (Table 1).The maximum of Peanut biological yield of treatments 30 % was obtained (Fig 1). The minimum of Peanut biological yield of treatments 10 % was obtained (Fig 1).

Analysis of variance showed that the effect of intercropping on peanut biological yield was significant was significant (Table 1). The maximum of peanut biological yield of treatments Sole peanut was obtained (Fig 2). The minimum of peanut biological yield e of treatments 100 + 25 + 75 was obtained (Fig 2).

Methanol spray is introduced as a suitable method which can increase CO2 assimilation (Hossinzadeh *et al.*, 2012). Foliar applications of methanol in various plants have been reported to improve yield and reduce stress (Ramirez *et al*, 2006) mainly via enhancing CO2 fixation rates (Nadali *et al.*, 2010). It has been stated that foliar utilization of methanol, as a source of carbon, increase the growth and yield of different plant species (Nadali *et al.*, 2010). Intercropping is one of the most common practices used in sustainable agricultural systems which have an important role in increasing the productivity and stability of yield in order to improve resource utilization and environmental factors (Alizadeh *et al.*, 2010). Intercropping legumes and non-legumes is an agricultural practice of cultivating two or more crops in the same place of land at the same time which is commonly practiced in many parts of the world in order to increase the productivity per unit area of the land (Bhupinder *et al.*, 2003).

Boll wet weight of Roselle

Analysis of variance showed that the effect of Methanol on boll wet weight of Roselle was significant (Table 2).

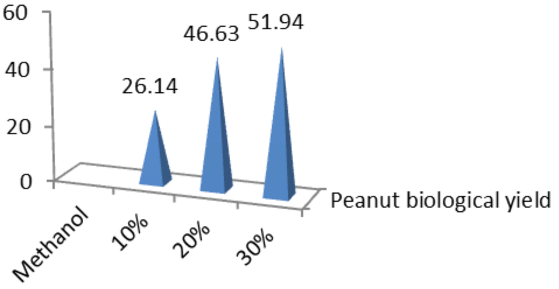

Fig 1: Average Comparison of peanut biological yield affect by foliar application of methanol

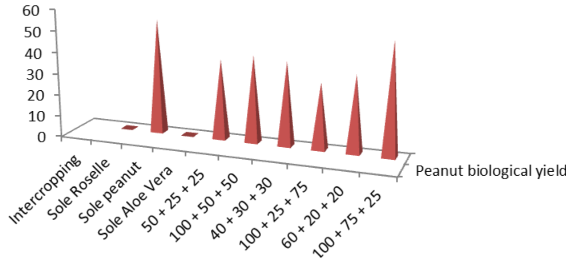

Fig 2: Average Comparison of peanut biological yield affect by intercropping

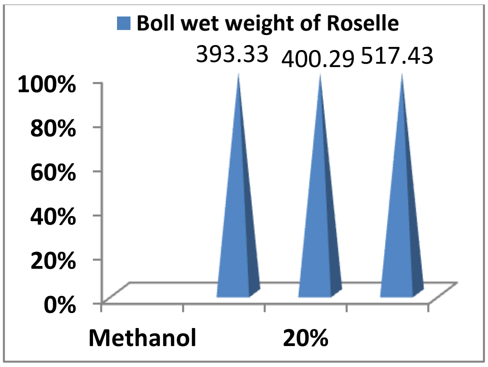

Fig 3: Average Comparison of peanut boll wet weight of Roselle affect by foliar application of methanol.

Table 1: Anova analysis of peanut biological yield affected by methanol and intercropping

Sov	df	Peanut biological yield
R	2	35.43
Methanol (M)	2	3899.21**
Error a	4	97.25
Intercropping (I)	6	662.90**
M*I	12	433.47**
Error b	36	69.97
CV	-	20.12

*, **, ns: significant at p<0.05 and p<0.01 and non-significant, respectively.

Table 2: Anova analysis of Boll wet weight of Roselle affected by methanol and intercropping

Sov	df	Boll wet weight of Roselle
R	2	3165.9
Methanol (M)	2	102096.4**
Error a	4	5494.1
Intercropping (I)	6	103988.8**
M*I	12	93450.9**
Error b	36	5101.3
CV	-	16.34

*, **, ns: significant at p<0.05 and p<0.01 and non-significant, respectively.

Table 3: Anova analysis of Roselle biological yield affected by methanol and intercropping

Sov	df	Roselle biological yield
R	2	1.22
Methanol (M)	2	27.29**
Error a	4	0.34
Intercropping (I)	6	26.12**
M*I	12	28.03**
Error b	36	2.03
CV	-	6.47

*, **, ns: significant at p<0.05 and p<0.01 and non-significant, respectively.

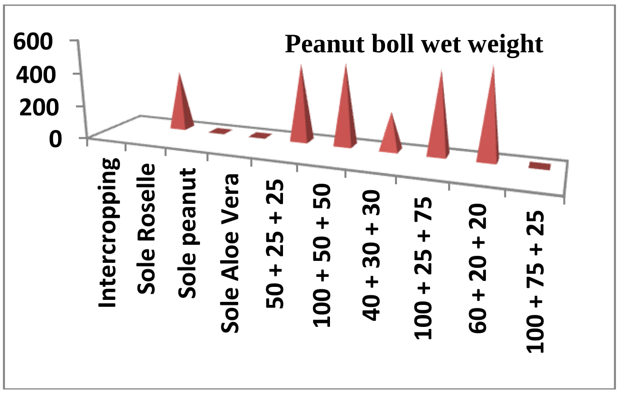

Fig 4: Average Comparison of boll wet weight of Roselle affect by intercropping

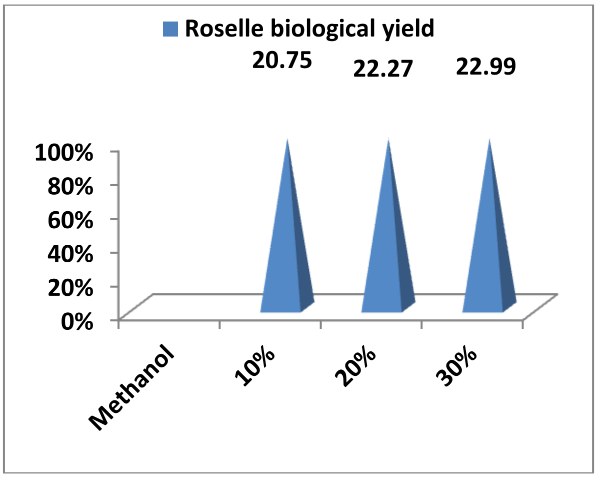

Fig 5: Average Comparison of peanut Roselle biological yield affect by foliar application of methanol.

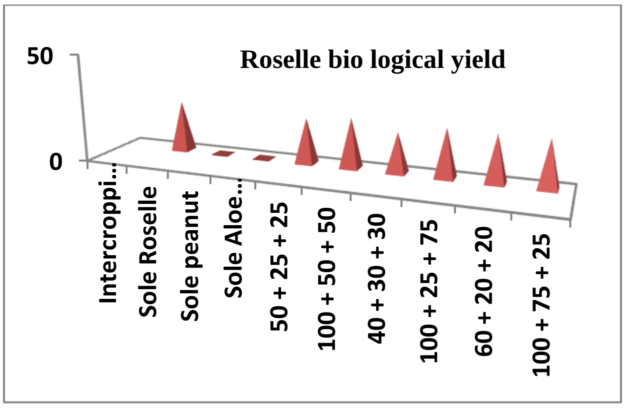

Fig 6: Average Comparison of Roselle biological yield affect by intercropping

The maximum of boll wet weight of Roselle of treatments 30% was obtained (Fig. 3). The minimum of boll wet weight of Roselle of treatments 10% was obtained (Fig. 3).

Analysis of variance showed that the effect of intercropping on boll wet weight of Roselle was significant was significant (Table 2). The maximum of boll wet weight of Roselle of treatments 60 + 20 + 20 was obtained (Fig 4). The minimum of boll wet weight of Roselle e of treatments 40 + 30 + 30 was obtained (Fig 4).

Methanol induced changes in critical compounds like jasmonate may be responsible for the observed results. It has been reported that the various metabolic pathways related to plant growth, development and defense mechanisms such as activation of genes involved in the jasmonic acid biosynthesis were affected by the exogenously applied methanol (Ramadan and Omran, 2005). Intercropping, also referred to as mixed cropping or polyculture, is the agricultural practice of cultivating two or more crops in the same space at the same time (Andrews and Kassam, 1976;). The component crops of an intercropping system do not necessarily have to be sown at the same time nor they have to be harvested at the same time, but they should be grown simultaneously for a great part of their growth periods. In intercropping, there is normally one main crop and one or more added crop(s), with the main crop being of primary importance for economic or food production reasons. The two or more crops in an intercrop normally are from different species and different plant families, or less commonly they may be simply different varieties or cultivars of the same crop, such as mixing two or more kinds of wheat seed in the same field. The most common advantage of intercropping is to produce a greater yield on a given piece of land by achieving more efficient use of the available growth resources that would otherwise not be utilized by each single crop grown alone. There are many different kinds of species that can be used for intercropping such as annuals, e.g. cereals and legumes, perennials, including shrubs and trees, or a mixture of the two (annuals and perennials). In the case of shrubs and trees the term mostly used is agroforestry (Anil *et al*., 1998).

Roselle biological yield

Analysis of variance showed that the effect of Methanol on boll wet weight of Roselle was significant (Table 3). The maximum of boll wet weight of Roselle of treatments 30% was obtained (Fig 5). The minimum of boll wet weight of Roselle of treatments 10% was obtained (Fig. 5).

Analysis of variance showed that the effect of intercropping on boll wet weight of Roselle was significant was significant (Table 3). The maximum of boll wet weight of Roselle of treatment Sole Roselle was obtained (Fig. 6). The minimum of boll wet weight of Roselle e of treatments 40 + 30 + 30 was obtained (Fig. 6).

The crops are not necessarily sown at the same time and their harvest time may be quite different, but they are usually simultaneously grown for significant growing periods (Willey, 1990). Research in different countries reveals that in addition to increasing the ecological and economic diversity, intercropping brings an increase in production or yield benefits, more efficient use of water resources, land, nutrients and labors, reduction in problems caused by pests, diseases and weeds (Awal *et al*., 2006). Regarding to increasing growth of the world population, demolition and overthrown of ecological balance of the systems, it is of a great importance to increase agricultural products and environmental preservation. Variety of methods have been developed and used to achieve high production rates including technological and genetic methods, and chemical fertilizers and herbicides; but use of such methodologies has helped us only partly in order to meet our needs in the area so food production has to be considered along with environmental conservation (Awal *et al*., 2006).

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