تأثير التسميد الأخضر والآزوتي في غلة المادة الخضراء والجافة لمحصول القطن وتوزعها على أجزاء النبات المختلفة ضمن ظروف سهل الغاب

Effect of Green Manure and Nitrogen Fertilizer on Cotton Fresh and Dry Matter Yield Distribution Among Different Plant Parts in AL-Ghab Plain

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الملخّص

نُفذت تجربة حقلية خلال موسمي النمو (2009 / 2010، 2010 / 2011) في مركز بحوث الغاب التابع للهيئة العامة للبحوث الزراعيةالسورية، وفق تصميم القطع المنشقة Split-Plot بثلاثة مكررات وست عشرة معاملة. بهدف دراسة تأثير التسميد الآزوتي من مصدرين الأول معدني (يوريا)، والثاني عضوي (تسميد أخضر بالمحاصيل البقولية) في غلة المادة الجافة والخضراء للأنسجة النباتية لمحصول القطن(السلالة 124) ضمن ظروف سهل الغاب. حيث استخدمت أربعة مستويات من التسميد الآزوتي المعدني (0،80،160،240) كغN.هـ$^{-1}$ وأربع معاملات تسميد أخضر هي (GM_0: شاهد دون تسميد أخضر، GM_1: تسميد أخضر بمحصول الفول، GM_2: تسميد أخضر بمحصول البازلاء، GM_3: تسميد أخضر بمحصول البيقية).

أظهرت النتائج استجابة الأنسجة النباتية الخضراء والجافة (أوراق، أفرع، مكونات ثمرية) لمحصول القطن للتسميد الآزوتي المعدني بشكلٍ معنوي في كل مستويات الإضافة بالمقارنة مع الشاهد (دون تسميد) وذلك عند كلٍ من مرحلتي الإزهار والنضج، وسبب التسميد الآزوتي الأخضرً والمعدني زيادة معنوية في أنسجة محصول القطن الخضراء والجافة، كذلك أظهرت النتائج زيادة معنوية في إنتاجية القطن من التيلة بالتسميد الآزوتي وأيضاً بالتسميد الأخضر، ولكن اختلفت الزيادة حسب نوع السماد الأخضر المستخدم، و حسب معدل التسميد الآزوتي المضاف، حيث تفوقت المعاملة GM_1N_{160} على باقي المعاملات بإنتاجيتها من التيلة والتي بلغت 1.82، 2.38 طن.هـ$^{-1}$، أي بزيادة قدرها 83.6 و73.15 % في كلا الموسمين على التوالي وذلك مقارنة بمعاملة الشاهد (دون تسميد آزوتي وتسميد أخضر) 0.99 ،1.37 طن.هـ$^{-1}$ في كلا الموسمين على التوالي.

وسُجلت أقل إنتاجية عند المعاملة GM_2N_0 (1.61،1.18) طن.هـ$^{-1}$ في كلا الموسمين على التوالي. ارتبطت إنتاجية القطن من التيلة مع إنتاجية محصول القطن للمادة الخضراء والجافة حيث بلغت 0.66،0.63 على التوالي في الموسم الأول، و 0.76،0.75 على التوالي في الموسم الثاني .

الكلمات المفتاحية : القطن، الآزوت المعدني، التسميد الأخضر، المادة الخضراء والجافة.

Abstract

Field experiment was conducted for two growing seasons (2009/2010 ,2010/2011) at AL-Ghab Center for Scientific Agricultural Research (Syria), (GCSAR) using split plot design with three replicates and sixteen treatments, to study the effect of two nitrogen sources fertilization the first : Mineral (Urea 46%) and the second: Organic (green manure with

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legume crops) and the impact of these two types of fertilizers on fresh and dry matter yield and distribution among different plant tissues of cotton crop (strain 124) under Al-Ghab plain conditions. Four levels of mineral nitrogen fertilization (0-80-160-240 kg $N.ha^{-1}$) and four treatments of green manure (GM_0: without green manure, GM_1: green manure with Faba Bean crop, GM_2: green manure with peas, GM_3: Green manure with Vetch) were used. The results showed that fresh and dry matter of cotton plant tissues(leaves, stems, fruiting forms) responded significantly to all levels of nitrogen fertilization, compared with control (without fertilization) on flowering and maturity stages. Green manure caused significant increase in fresh and dry matter yield, also inorganic nitrogen and green manure fertilizers caused significant increase in cotton lint yield, but this increase varies with the type of legume crops, which used as a green manure and with rate of inorganic nitrogen fertilizer application, the highest productivity cotton lint occurred at the treatment GM_1N_{160}, 1.82, 2.38 $t.ha^{-1}$, an increase of (83.6, 73.15)% in both seasonal respectively, compared with control GM_0N_0 (without fertilization N and GM) 0.99, 1.37 $t.ha^{-1}$in both seasonal respectively, while the lowest productivity of cotton lint was found at the treatment GM_2N_0 (1.18, 1.61) $t.ha^{-1}$ in both seasonal respectively. The cotton lint yield was correlated with fresh and dry matter yield which reached (0.63 ,0 .66) respectively in the first seasonal, and (0.75 , 0.76) respectively in the second seasonal.

Key words: Cotton , Inorganic nitrogen , Green Manure , Fresh and Dry Matter

Introduction

Cotton is a key crop around the world for fiber production. Although cotton (*Gossypium hirsutum* L.) is grown under different climatic zones, soil classes and multiple agricultural systems, still its growth and developments are regulated mainly by external environmental factors, such as soil, air temperature, photoperiod, water and nutrients stress and bioavailability. The short staple cotton variety is the most widely grown around the world and contributes about 90% of the current world production (Lee, 1984).

Cotton is one of the most important fiber crop in the world, and called white gold, because of the high price and the large number of people working on it. The estimated global area planted with cotton is about 31 million hectares distributed over eighty countries (FAO, 2007). Cotton is grown in tropical and temperate regions, which are located between latitudes 45 degrees north of the equator and 35 degrees south of the equator (Al Fares, 1985). Egypt, Syria and Sudan is the main Arab countries producing cotton (Al Fares, 1990).

Cotton in Syria is ranked the second after oil in securing foreign exchange, and the third after wheat and oil in securing the national income and providing raw materials for spinning and weaving, and more than a million people works in various stages of cultivation, production, ginning, marketing, manufacturing and trade. AL-Ghab is considered as one of the important areas growing cotton in Syria, where it is a basic income for a large segment of the farmers in addition to providing a large number of jobs and a good pasture for sheep and cattle after harvest, cultivated area in AL-Ghab is ranging between 10-20 thousand hectares per year. In AL-Ghab plain, cotton is grown on an area of 7305 ha with a total production of 25144 tons of seed cotton and a productivity of 3.442 $t.ha^{-1}$ in 2011 (Syrian statistical, 2011).

Greater attention is being paid to N fertilizer management because of the global consequences of green-house gas emissions (Snyder et *al.,* 2007). Nitrous oxide emissions are exacerbated by excessive N fertilizer use, which can also reduce yield and delay harvest.

Understanding N uptake and recovery is essential for determining the most suitable N requirements and timing. Sabbe and Zelinski (1990) pointed out that it is very important to understand nutrient uptake patterns for specific crops prior to interpreting the data related to plant tissue analysis, since there are differences among species, varieties, and locations.

Nitrogen is required through all stages of plant development because, it is an essential element for both the structural (cell membranes) and nonstructural (amino acids, enzymes, protein, nucleic acids and chlorophyll) components of the plant. Without sufficient N, deficiency symptoms in cotton include stunting, chlorosis, and fewer and smaller bolls (Radon and Maundy, 1984). Balancing crop N demand and supply from the soil is essential for sustainable crop growth and development (Olson and Kurtz, 1982). Constant removal of N with the harvest or improper N management will eventually cause deficiencies and substantially reduce yield (Balasubramanian et *al.,* 2004).

The total Nitrogen content of the tillage layer in agricultural soils ranges between 0.02 and 0.4% (Dormosh et *al.,* 1990). and it exists in two forms: mineral form, that the plant benefit from and constitutes about 1% of the total nitrogen in the soil, in the form of nitrate (NO_{3-}) that are found in the soil solution, and ammonium ions (NH_{4+}), which is mostly adsorbed on the clay particles, and low available to plant, organic form, which constitutes 99% of the total nitrogen in the soil (Tisdale et *al.,* 1993). Furthermore, Morrow and Krieg (1990) reported that cotton response to N fertilization is very often difficult to predict, and mostly linked to initial soil $N^{-}NO_{3-}$ level. Therefore, the availability of N from previous cultivation and residues will considerably affect the N management of the succeeding cotton crop and should be seriously considered. Among the plant nutrients, nitrogen plays a very important role in crop productivity, because it is an important determinant of the growth and yield of irrigated cotton (Ahmad, 1998).

In the case of cotton, N deficiencies will produce fewer branches and induce early fruit shedding and premature termination of fruit formation, while an excess supply can create rank growth and delay boll opening and maturity (Chaudhry and Guitchonouts, 2003).

Wright et *al.,* (1998) also observed that significantly higher lint yields with the application of 134 kg N. ha^{-1} than 67 kg N. ha^{-1} . Sawan et *al.,* (2006) found that seed cotton and lint yield, boll numbers, boll weight and the number of open bolls per plant significantly increased with increasing N application rate from 95 to 143 kg ha^{-1}. Yield decrease, sometimes reported as a result of N application above the optimum level (Howard et *al.,* 2001).

In the past couple of decades, concerns about the environmental impacts of modern agriculture and a growing interest in alternative crop management techniques have intensified the need for quantifying nitrogen (N) behavior in soi1 (Frissel, 1977). These concerns have spurred research into nitrogen cycling in cropping systems receiving different organic matter and nitrogen inputs (van Faassen and Lebbink, 1994), as well as systems utilizing different tillage practices (Dou et *al.,* 1995). Legumes have long been advocated as the missing ingredient for conserving soil resources in subsistence agriculture (Thapa, 1996). These include green manures practices. Green manuring practices such as the growing of legumes, avails a form of management (through keeping a continuous layer of organic residue on the soil surface) which simulates the forest ecosystem (IITA, 1992); and has the additional potential of bringing extra nitrogen into the system (Henao and Baanante, 1999). Synchronization of residue N release and fertilizer N amendments with crop N demand is important for maximum, efficient utilization of N, and minimum losses from the plant-soi1 system (Wilson and Hargrove, 1986).

The main primary nitrogen source in organic farming systems is provided by biological N^{-2} fixation by integrating legumes in the crop rotation. As a rule, a percentage of legumes of about one fourth to one third of the main crops is necessary to ensure the nitrogen supply of the crop rotation (Mayer, 2003). The use of organic inputs such as leguminous green manure and crop residues could be an alternative for maintaining soil fertility and sustain crop yields (Zoumane et *al.,* 2000). Generally, it has been highlighted that a leguminous crop producing 8 to 25 tons of green matter per hectare, will add about 60 to 90 kg of nitrogen when incorporated into the soil (Patnaik, 2004).

Effective use of GMs is often hampered by lack of precise information about N availability for future crops. Nitrogen accumulation and subsequent release from decomposing GMs depends largely on residue composition and N concentration, temperature, water availability, and residue management (Schomberg et *al.,* 1994), which in turn depend on GM species, site environment (climate, soil, weather, etc.), and cropping system.

The slow release of N from decomposing green manure residues may be better timed with plant uptake, possibly increasing N-uptake efficiency and crop yield while reducing N leaching losses (Bath, 2000). The increased plant N following broad bean and hairy vetch incorporation could possibly be attributed to the N contribution from above ground biomass incorporation and below ground residues of the legumes. A rapid increase in soil microorganisms occurs after a young, relatively lush green manure crop is incorporated into the soil. The soil microbes multiply to attack the freshly incorporated plant material. During microbial breakdown, nutrients held within the plant tissues are released and made available to the following crop (Sullivan, 2003).

Rochester et *al.,* (1998) studied nitrogen fixation and residual fixed nitrogen (including estimates of below-ground nitrogen) in 98 legume crops grown in rotation with cotton, and found that faba beans, field pea and vetch fixed 177, 161and 171 kg N.ha^{-1} respectively. Rochester et *al.,*(2001) averaged over the three experiments, cotton following non-legume rotation crops required the application of 179 kg N ha^{-1}, whilst following the grain- and green-manure legume systems required only 90 and 52 kg N ha^{-1}, respectively.

The objectives of this study are;

To study the effect of different levels of mineral nitrogen fertilization and different sources of green manure on the production of fresh and dry matter at its partitioning into different plant parts of cotton crop at flowering and maturity stage.

To determine the optimum combination of nitrogen treatments to achieve the highest lint cotton yield.

Materials and Methods

This research was carried out at AL-Ghab Research Center-Hama during (2009/2010, 2010/2011) growing seasons, on a sandy clay soil. Compound soil samples (0-30 and 30-60 cm) were collected before planting indicated that pH was 7.73, organic matter was good, calcium carbonate from medium to high content, rich in available phosphorus, and poor content of boron and mineral nitrogen Table (1).

Plots were 10 m in length and consisted of 6 rows of cotton planted with row spacing of 0.75 m. Plots were over seeded and then thinned to 1 plant per 20 cm of row, or a population of 66,666 plants ha^{-1}, at approximately the first or second true leaf stage. Management was consistent with typical agronomic practices used for upland production in the region. Four green manure treatments of (GM_0: without green manure, GM_1: Faba Bean as green manure, GM_2: pea as green manure, GM_3:vetch as green manure) and Four N fertilizer treatments of 0, 80,160 and 240 kg.ha^{-1} N as Urea. Each N fertilizer treatment received at pre-planting N rate of 20% of total rate, 40% after thinning, 20% at flowering stage and the last portion was added after 15 days from the flowering stage (20% of total rate). A split plot experimental design was used with green manure as main plots and N fertilizer treatments as subplots.

Green manures were planted on 20 October, 2009 in the first year and on 10 October, 2010 in the second year and at the flowering stage ploughed into soil on 20 March, 2010 in first year and on 16 March, 2010 in second year, and on 28 April, 2010- 25 April ,2011 cotton seeds (strain124) were planted.

Green manure samples

Whole above-ground plant samples (total area 1m^2) from every type legume crops which used as green manure were collected from three replicates at flowering stage before it ploughed into soil. Plant samples were separated immediately into stems, leaves and flowers. All plant tissues generated from the labeled sub-plots were weighed and dried.

Cotton plant samples

Whole above-ground plant samples (five plants per sample) were collected from the corresponding subplots at flowering and maturity in each growing season by cutting the main stem immediately below the cotyledonary node. Plant samples were separated immediately into stems, leaves and fruiting parts (squares, flowers, immature bolls, burs,) in flowering stage and fruiting parts (squares, flowers, immature and mature bolls, burs, lint and seeds) in maturity stag. All these components were weighed immediately after separated as afresh matter yield. Mature bolls were weighed and then partially delineated, seeds and burs dried and ground, further, mixed uniformly with the other components of the fruiting forms. All plant tissues generated from the labeled sub-plots were weighed and dried.

Lint cotton yield was determined by hand harvesting from the center 4 rows of each plot, and separated the seeds cotton yield into seeds and lint, finally weighed lint cotton yield was recorded.

All data were statistically analyzed and means were separated with the $LSD_{0.05}$ using GenStat 7 program.

Table1. Some selected soil chemical and physical properties.

Growing Season	Depth	pH	EC (1:5)	Av.P	Av.K	Mineral-N	$CaCO_3$	OM	Sand	Silt	Clay	Soil Texture
	cm	1:2.5	$dS.m^{-1}$	mg/Kg	mg/Kg	mg/Kg	%	%	%	%	%	sandy clay
2009/2010	0-30	7.73	0.23	23.2	220	3.45	29.7	2.28	42	14	44	
	30-60	7.85	0.24	16	210	1.85	31.4	2.14	44	10	46	
2010/2011	0-30	7.62	0.18	22.18	270	4.36	26.3	2.32	46	12	42	sandy clay
	30-60	7.78	0.18	18.5	240	2.5	27.1	2.14	48	10	42	

Results and Discussion

Green manure: fresh and dry matter yield;

Results shown in the table (2) different types of legume crops in the fresh biomass which planted in AL-Ghab plain soil, all kinds of leguminous crops increased significantly compared with the control treatment (herbs winter growth in the treatment of the control plots) in the production of fresh biomass in both seasons, all green manure fresh biomass components (stems, leaves and flowers) increased significantly to the treatment of the control GM_0, Faba bean growing and give highest fresh biomass components (stems, leaves and flowers) in both seasons compared with other green manure crop (Peas and Vetch), Faba bean gives fresh stems weight (16.44, 20.84) $t.ha^{-1}$ in both seasons respectively, and fresh leaves weight (15.76, 18.17) $t.ha^{-1}$ respectively, and gives fresh flowers weight (1.70, 2.12) $t.ha^{-1}$ in both seasons respectively, In the case of green manure dry matter, All treatment increased significantly compared with control. Faba bean gives dry stems weight (1.47, 2.25) $t.ha^{-1}$ in both seasons respectively, and dry leaves weight (1.84, 2.30) $t.ha^{-1}$ respectively, and gives dry flowers weight (0.19, 0.27) $t.ha^{-1}$ in both seasons respectively. The importance of legume crop fresh biomass with reflected these crops of adaptation with the environmental conditions of the study area, (Fowler et *al,* 2004) found that the amount of fresh biomass for leguminous crops fits with quantity nutrients which absorbed from the soil.

These data agree with the results of (Evans et *al.,* 2001) who found that the types and varieties of legume crops which grow in the same location different with them in both dry matter yield and the quality of the remains.

Table 2. Type of green manure: fresh and dry matter yield t.ha^{-1}.

		2009/2010		2010/2011	
Green manure type	Plant Part Tissues	Green biomass t.ha^{-1}	Dry matter Yield t.ha^{-1}	Green biomass t.ha^{-1}	Dry matter Yield t.ha^{-1}
Without green manure (Winter weeds) GM_0	Leaves	1.12 (52.0 %)	0.18 (52.0%)	0.91 (59.00 %)	0.17 (89.30%)
	Stems	0.91 (42.0 %)	0.15 (42.0%)	0.56 (36.00 %)	0.01 (5.54%)
	Flowers	0.13 (6.0 %)	0.02 (6.0%)	0.08 (0.99 %)	0.01 (5.16%)
Faba bean GM_1	Leaves	15.76 (46.5 %)	1.84 (52.6%)	18.17 (44.18 %)	2.30 (47.71%)
	Stems	16.44 (48.5 %)	1.47 (42.0%)	20.84 (50.67 %)	2.25 (46.70%)
	Flowers	1.70 (5.0 %)	0.19 (5.4%)	2.12 (5.15 %)	0.27 (5.59%)
Peas GM_2	Leaves	6.75 (62.6 %)	0.72 (61.9%)	9.32 (56.98 %)	1.01 (60.54%)
	Stems	3.89 (36.1 %)	0.43 (36.9%)	6.58 (40.24 %)	0.61 (36.53%)
	Flowers	0.14 (1.3 %)	0.01 (1.2%)	0.46 (2.79 %)	0.05 (2.93%)
Vetch GM_3	Leaves	11.95 (55.4 %)	1.64 (57.2%)	12.23 (56.89 %)	1.60 (60.27%)
	Stems	9.42 (43.7%)	1.20 (42.0%)	8.94 (41.57 %)	1.02 (38.28%)
	Flowers	0.21 (1.0 %)	0.02 (0.8%)	0.33 (1.54 %)	0.04 (1.45%)
		$LSD_{0.05}$	$LSD_{0.05}$	$LSD_{0.05}$	$LSD_{0.05}$
	Leaves C.V%	1.607** (10.2)	0.1058** (5.1)	1.346** (7.7)	0.1484** (6.5)
	Stems C.V%	1.605** (11.1)	0.1954** (11.8)	1.615** (9.7)	0.1870** (10.3)
	Flowers C.V%	0.0832** (9.8)	0.00863** (8.9)	0.1199** (10.4)	0.00859** (6.1)

Dry matter yield of cotton plant tissues at flowering stage $t.ha^{-1}$:

Results showed in the table (3) significant effects of green manure treatments on the dry matter yield of cotton plant tissues at flowering stage, GM_1(Faba bean) and GM_3(vetch) treatments had significantly higher stems dry matter (2.03,1.85) $t.ha^{-1}$ respectively in the first growing season compared with control GM_0(Without green manure). GM_2(Peas) was not significant with control, GM_1(Faba bean), GM_2(Peas) and GM_3(Vetch) treatments had significantly higher stem dry matter (2.28, 1.91, 2.13) $t.ha^{-1}$ respectively in the second growing season compared with control GM_0, leaves dry matter increased significantly of green manure treatments in two growing seasons, and the best treatment green manure which given highest leaves dry matter was GM_1N_0 compared with control GM_0N_0. fruiting forms dry matter (squares, flowers, immature bolls, burs) increased significantly of green manure treatments in two growing seasons, at flowering stage the fruiting forms dry matter has the lowest weight compared with leaves and stems, because in this stage all fruiting forms(squares, flowers, immature bolls, burs) are small and little compared with leaves and stems weight. The dry matter for green manure control treatment at flowering stage during the 2010 growing season was (1.63 to 2.77) $t.ha^{-1}$ in stems, (1.32 to 2.92) $t.ha^{-1}$ in leaves and (0.81 to 2.07) $t.ha^{-1}$ in fruiting forms. , In fact, under green manure with Faba bean was (1.85 to 3.21) $t.ha^{-1}$ in stems, (1.97 to 3.25) $t.ha^{-1}$ in leaves and (1.19 to 2.11) $t.ha^{-1}$ in fruiting forms. During the 2011 growing season the dry matter of green manure control treatment at flowering stage was (1.62 to 3.06) $t.ha^{-1}$ in stems, (1.60 to 2.89) $t.ha^{-1}$ in leaves and (1.19 to 2.34) $t.ha^{-1}$ in fruiting forms. Whereas, under green manure with Faba bean the dry matter distributed as follow: stems between 2.28 to 4.12 $t.ha^{-1}$; leaves between 1.99 to 2.85 $t.ha^{-1}$; and fruiting forms between 2.21 to 2.66 $t.ha^{-1}$.

The different dry matter between treatment reflect with the quantity of nitrogen released from green manure and inorganic fertilizer, nitrogen accumulation and subsequent released from decomposing green manure depends largely on residue composition and N concentration, temperature, water availability, and residue management (Andren, 1992), which in turn depend on green manure species and site environment (climate, soil, weather, etc.). So synchronization of residue N release and fertilizer N amendments with crop N demand is important for maximum, efficient utilization of N, and minimum losses from the plant-soi1 system (Wilson and Hargrove, 1986).

The best rate of N fertilizer was N_{240} under green manure with Peas GM_2 which giving the highest in all dry matter of cotton plant part, which reached in stems to (2.66, 3.63) $t.ha^{-1}$ respectively in two growing seasons, leaves to (3.06, 2.93) $t.ha^{-1}$, and in fruiting forms (2.15, 2.46) $t.ha^{-1}$ respectively in two growing seasons. Similarly, under green manure with Vetch GM_3 , The best rate of N fertilizer was N_{240} which giving the highest in all dry matter which reached in stems to (2.90, 3.96) $t.ha^{-1}$ respectively in two growing seasons, leaves to (3.20, 2.70) $t.ha^{-1}$, and in fruiting forms (2.38, 2.68) $t.ha^{-1}$ respectively in two growing seasons.

Nitrogen which defended the vegetative growth and increase nitrogen in soil may lead to the increase in dry matter yield of cotton plant tissues might be attributed to the role of increased vegetative growth significantly (Douglas et *al.,* 1984).

Fresh matter of cotton plant tissues at maturity stage:

Data showed that the fresh matter weight significantly increased with increasing N rates (Table4). In 2010 growing season , this increase approached (3.32, 5.61, 9.15) $t.ha^{-1}$ compared with control N_0 under main plots (without green manure) for N_{80} N_{160} and N_{240} respectively in stems. And increase approached (2.74, 4.62, 6.78) $t.ha^{-1}$ compared with control N_0 for N_{80} N_{160} and N_{240} respectively in leaves. And increase approached (2.71, 4.49, 6.3) $t.ha^{-1}$ compared with control N_0 for N_{80} N_{160} and N_{240} respectively in fruiting forms. The N_{240} treatment increased the all fresh matter weight (stems, leaves and fruiting forms) significantly compared with N_{80}, N_{160}, and this increase approached (5.83 and 3.54) $t.ha^{-1}$ respectively in stems. And to (4.04 and 2.16) $t.ha^{-1}$ respectively in leaves. also this increase approached (3.59 and 1.81) $t.ha^{-1}$ respectively in fruiting forms.

Table 3. Effects of green manure and nitrogen fertilization treatments on dry matter of cotton plant tissues at flowering stage.

		Flowering stage					
		2009/2010			2010/2011		
Green manure type	N levels	Stems $t.ha^{-1}$	Leaves $t.ha^{-1}$	Fruiting Forms $t.ha^{-1}$	Stems $t.ha^{-1}$	Leaves $t.ha^{-1}$	Fruiting Forms $t.ha^{-1}$
Without green Manure	N_0	1.63	1.32	0.81	1.62	1.60	1.19
	N_{80}	1.76	1.98	1.73	2.62	1.98	1.84
	N_{160}	2.21	2.41	1.85	2.92	2.44	2.15
	N_{240}	2.77	2.92	2.07	3.06	2.89	2.34
Faba bean GM_1	N_0	1.85	1.97	1.19	2.28	1.99	2.21
	N_{80}	2.53	2.44	1.55	2.82	2.21	2.75
	N_{160}	2.68	3.01	1.94	3.50	2.54	2.63
	N_{240}	3.21	3.25	2.11	4.12	2.85	2.66
Peas GM_2	N_0	1.52	1.41	0.94	1.91	1.97	1.30
	N_{80}	2.08	2.06	1.78	2.47	2.38	1.91
	N_{160}	2.28	2.72	1.88	3.05	2.59	2.28
	N_{240}	2.66	3.06	2.15	3.63	2.93	2.46
Vetch GM_3	N_0	2.03	1.83	1.25	2.13	2.15	1.55
	N_{80}	2.34	2.44	1.93	3.07	2.13	2.07
	N_{160}	2.76	2.98	2.23	3.21	2.49	2.62
	N_{240}	2.90	3.20	2.38	3.96	2.70	2.68
$LSD_{0.05}$	GM	0.2581^{*}	0.1791^{*}	0.1369^{*}	0.1455^{**}	0.1731^{ns}	0.2308^{*}
	N	0.1513^{**}	0.1690^{**}	0.1277^{**}	0.2512^{**}	0.1780^{**}	0.2127^{**}
	GM *N	0.3410^{ns}	0.3259^{ns}	0.2470^{ns}	0.4492^{ns}	0.3375^{ns}	0.4123^{ns}
C.V%		7.7	8.2	8.7	10.3	8.9	11.7

Table 4. Effects of green manure and nitrogen fertilization treatments on fresh matter of cotton plant tissues at maturity stage.

		Maturity stage					
		2009/2010			2010/2011		
Green manure type	N levels	Stems $t.ha^{-1}$	Leaves $t.ha^{-1}$	Fruiting Forms $t.ha^{-1}$	Stems $t.ha^{-1}$	Leaves $t.ha^{-1}$	Fruiting Forms $t.ha^{-1}$
Without green manure	N_0	4.93	7.12	8.55	5.08	8.30	7.09
	N_{80}	7.64	9.86	11.87	7.93	11.31	13.04
	N_{160}	9.42	11.74	14.16	9.57	13.87	16.40
	N_{240}	11.23	13.90	17.70	10.36	17.34	20.16
Faba bean GM_1	N_0	6.64	9.54	9.73	6.81	10.82	10.15
	N_{80}	8.85	11.60	13.59	9.28	13.42	16.39
	N_{160}	11.34	13.21	16.82	10.39	15.66	21.35
	N_{240}	12.31	15.79	18.84	11.44	20.56	24.91
Peas GM_2	N_0	5.57	9.14	7.96	6.10	10.03	9.62
	N_{80}	7.86	10.24	12.67	9.07	12.91	15.35
	N_{160}	10.05	12.07	15.05	9.81	15.90	18.84
	N_{240}	11.26	14.23	17.21	10.88	17.36	23.06
Vetch GM_3	N_0	5.70	9.77	8.79	6.59	10.20	9.58
	N_{80}	8.64	10.83	13.59	8.73	13.23	16.15
	N_{160}	10.93	12.70	15.92	9.98	15.66	20.04
	N_{240}	12.38	15.08	17.28	10.95	18.95	24.02
$LSD_{0.05}$	GM	0.519^{*}	1.0093^{*}	0.963^{*}	0.958^{ns}	1.064^{*}	1.726^{*}
	N	0.690^{**}	0.5761^{**}	0.681^{**}	0.610^{**}	0.983^{**}	1.241^{**}
	GM *N	1.261^{ns}	1.3147^{ns}	1.423^{ns}	1.326^{ns}	1.905^{ns}	2.578^{ns}
C.V%		9.0	5.9	5.9	8.1	8.3	8.9

In 2011 growing season , this increase approached (5.95, 9.31, 13.07) $t.ha^{-1}$ compared with control N_0 under main plots (without green manure) for N_{80}, N_{160}, and N_{240} respectively in stem. And increase approached (3.01, 5.57, 9.04) $t.ha^{-1}$ compared with control N_0 for N_{80}, N_{160}, and N_{240} respectively in leaves. And increase approached (2.85, 4.49, 5.28) $t.ha^{-1}$ compared with control N_0 for N_{80}, N_{160}, and N_{240} respectively in fruiting forms. The N_{240} treatment increased the all fresh matter weight (stems, leaves and fruiting forms) significantly compared with N_{80}, N_{160}, and this increase approached (7.12and 3.76) $t.ha^{-1}$ respectively in stem. And to (6.03and 3.47) $t.ha^{-1}$ respectively in leaves. Also this increase approached (2.43and 0.79) $t.ha^{-1}$ respectively in fruiting forms. This could be attributed to the fact that excess N supply can create rank growth and delay boll opening and maturity (Chaudhry and Guitchonouts,2003).

Data in Table 4 also indicated that the effects of green manure treatment on fresh matter weight are significant. In 2010 growing season, GM_1(Faba bean), GM_2(peas) and GM_3(vetch) treatments increased significantly the stem fresh matter weight 1.71, 0.64, and 0.77 $t.ha^{-1}$ compared with GM_0 under level N_0.and also increased significantly the leaves fresh matter weight 2.42, 2.02, and 2.65$t.ha^{-1}$ compared with GM_0 under level N_0. But only GM_1(Faba bean) increased significantly the fruiting forms fresh matter weight. The highest significant all fresh matter weight was obtained with GM_1(Faba bean) compared with GM_3(vetch) and GM_2(peas). In 2011 growing season, the effects of green manure treatment on fresh matter weight are significant, in leaves and fruiting forms fresh matter weight , but in case stem fresh matter weight the effects of green manure treatment are not significant.

Data also indicated that the interaction of GM and N was not significant in all fresh matter weight (stems, leaves and fruiting forms) at two growing seasons. The highest all fresh matter weight was obtained with the GM_1N_{240} treatment.

Dry matter of cotton plant tissues at Maturity stage:

The average dry matter production and distribution among various cotton plant's tissues throughout the two growing seasons are shown in Table 5.

In 2010 growing season, Average dry matter production among the N fertilizer treatments under main plots GM_0 (without green manure) distributed in cotton plant parts as stems between 2.26 for N_0 to 4.90 for N_{240}, leaves between 1.99 for N_0 and 3.61for N_{240}, and fruiting forms between 4.62 for N_0 to 7.93 for N_{240} treatment. In comparison, plants from the green manure cotton produced an average dry matter, under split plot N_0, dry matter in GM_1(Faba bean) distributed as stems, 2.89; leaves, 2.57 and fruiting forms 5.06 $t.ha^{-1}$. And in GM_2(peas) stems, 2.54; leaves, 2.49 and fruiting forms 4.15 $t.ha^{-1}$. In case GM_3(vetch) dry matter distributed as stems, 2.66; leaves, 2.60 and fruiting forms 4.58 $t.ha^{-1}$.

In 2011 growing season, average dry matter production among the N fertilizer treatments under main plots GM_0 (without green manure) distributed in cotton plant parts as; stems between 2.64 for N_0 to 3.99 for N_{240}, leaves between 2.25 for N_0 and 3.96 for N_{240} and fruiting forms between 4.67 for N_0 to 9.26 for N_{240} treatment.

In comparison, plants from the green manure cotton produced an average dry matter, under split plot N_0,dry matter in GM_1(Faba bean) distributed as stems, 3.00; leaves, 2.69 and fruiting forms 6.26 $t.ha^{-1}$. And in GM_2 (peas) stems, 2.95; leaves, 2.63 and fruiting forms 5.86 $t.ha^{-1}$. In case GM_3(vetch) dry matter distributed as stems, 3.00; leaves, 2.68 and fruiting forms 6.10 $t.ha^{-1}$.

Our results about dry matter of cotton plant tissues at maturity stage were similar to those reported by (Bassett et *al,*1970), and in Syria our results were similar with (Janat and Somi, 2001) which founded dry matter significantly increased with increasing N rates.

Data also indicated that the interaction of GM and N was not significant in total dry matter weight (stems, leaves and fruiting forms) at two growing seasons. The highest total dry matter weight was obtained with the $N_{240}GM_1$ treatment.

Table 5. Effects of green manure and nitrogen fertilization treatments on dry matter of cotton plant tissues at maturity stage.

		Maturity stage					
		2009/2010			2010/2011		
Green manure type	N levels	Stems $t.ha^{-1}$	Leaves $t.ha^{-1}$	Fruiting Forms $t.ha^{-1}$	Stems $t.ha^{-1}$	Leaves $t.ha^{-1}$	Fruiting Forms $t.ha^{-1}$
Without green manure	N_0	2.26	1.99	4.62	2.64	2.25	4.67
	N_{80}	3.30	2.61	6.21	3.37	2.89	6.89
	N_{160}	4.06	3.13	7.15	3.89	3.31	8.40
	N_{240}	4.90	3.61	7.93	3.99	3.96	9.26
Faba bean GM_1	N_0	2.89	2.57	5.06	3.00	2.69	6.26
	N_{80}	3.64	3.09	7.01	3.66	3.29	8.00
	N_{160}	4.67	3.41	8.08	3.98	3.47	9.58
	N_{240}	5.19	4.00	8.38	4.21	4.39	10.83
Peas GM_2	N_0	2.54	2.49	4.15	2.95	2.63	5.86
	N_{80}	3.33	2.69	6.60	3.60	3.24	7.78
	N_{160}	4.25	3.19	7.44	3.85	3.77	8.78
	N_{240}	4.59	3.70	7.76	4.16	3.96	10.51
Vetch GM_3	N_0	2.66	2.60	4.58	3.00	2.68	6.10
	N_{80}	3.58	2.90	6.98	3.58	3.33	7.95
	N_{160}	4.60	3.35	7.64	3.89	3.56	9.17
	N_{240}	5.21	3.76	7.94	4.13	4.15	10.66
$LSD_{0.05}$	GM	0.2730^{*}	0.1879^{*}	0.5049^{ns}	0.2855^{ns}	0.2154^{*}	0.7972^{*}
	N	0.2598^{**}	0.2041^{**}	0.2660^{**}	0.2504^{**}	0.1922^{**}	0.5833^{**}
	GM *N	0.5002^{ns}	0.3835^{ns}	0.6322^{ns}	0.4910^{ns}	0.3754^{ns}	1.2044^{ns}
C.V%		8.0	7.9	4.7	8.2	6.8	8.5

Lint cotton yield t.ha^{-1}:

Data indicated that the effects of green manure treatment on lint yield are significant, In 2010 growing season, GM_1(Faba bean), and GM_3(vetch) treatments increased significantly the lint yield (1.562 and 1.538) t.ha^{-1} comparing the means with control GM_0(Without green manure). GM_2(peas) increased lint yield but this increase was not significant. While there were no significant difference among GM_1(Faba bean), GM_2 (peas) and GM_3 (vetch) treatments. In 2011 growing season, GM_1 (Faba bean), GM_2(peas) and GM_3 (vetch) treatments increased significantly the Lint yield (2.087, 2.029 and 2.043) t.ha^{-1} respectively comparing the means with control GM_0(Without green manure). While there were no significant difference among GM_1(Faba bean), GM_2(peas) and GM_3(vetch) treatments. Similarly, (Hearn, 1986), found that a legume crop grown prior to cotton could enhance lint yield, and (Rochester et *al,* 1998) reported that faba beans, field pea and vetch fixed 177, 161and 171 kg N.ha^{-1} respectively and this tended to increase lint yield t.ha^{-1},

Table 6. Effects of green manure and nitrogen fertilization treatments on lint yield (t.ha^{-1}) In 2010 growing season.

	Without green manure	Faba bean	Peas	Vetch	
N levels	GM_0	GM_1	GM_2	GM_3	Mean
N_0	0.993	1.298	1.182	1.350	1.206
N_{80}	1.265	1.598	1.386	1.634	1.471
N_{160}	1.531	1.823	1.630	1.741	1.681
N_{240}	1.572	1.530	1.504	1.426	1.508
Means	1.340	1.562	1.425	1.538	1.466
$LSD_{0.05}$		GM*N ns	N = 0.108	GM =0.139	

CV%= 8.7

Table 7. Effects of green manure and nitrogen fertilization treatments on lint yield (t.ha^{-1}) In 2011 growing season.

	Without green manure	Faba bean	Peas	Vetch	
N levels	GM_0	GM_1	GM_2	GM_3	Mean
N_0	1.372	1.677	1.608	1.635	1.573
N_{80}	1.883	2.082	1.999	2.071	2.009
N_{160}	2.103	2.377	2.359	2.345	2.296
N_{240}	2.039	2.213	2.152	2.122	2.132
Means	1.849	2.087	2.029	2.043	2.002
$LSD_{0.05}$		GM*N ns	N = 0.152	GM =0.109	

CV%= 9

Data in Table (6) show that lint yield significantly increased with increasing N rates. This increase approached (0.265, 0.476, and 0.302) $t.ha^{-1}$ for N_{80}, N_{160}, and N_{240} respectively compared with the mean of control N_0.and data in Table (7) show that lint yield significantly increased with increasing N rates. This increase approached (0.435, 0.722 , and 0.558) $t.ha^{-1}$ for N_{80}, N_{160}, and N_{240} respectively compared with the mean of control $N_{0.}$ The N_{160} treatment increased the lint yield significantly compared with N_{80} in two seasons, while there were no significant difference between N_{240} and N_{80} in the second season only. This could be attributed to the fact that excess N supply can creates rank growth and delay boll opening and maturity (Chaudhry and Guitchonouts,2003). The lint yield observed in this study agrees with those obtained by (Sawan et *al.,* 2006), when lint yield significantly increased with increase in the N rate from 95 to 143 kg ha^{-1}.

Data also indicated that interaction between GM and N was significant. The highest lint yield was obtained with the $N_{160}GM_1$ treatment in two seasons.

(Rochester et *al.,* 1998), reported that averaged over the three experiments, cotton following non-legume rotation crops required the application of 179 kg N ha^{-1}, whilst following the grain and green manure legume systems required only 90 and 52 kg N ha^{-1}, respectively to give a high lint yield $t.ha^{-1}$.

Conclusions

The outcome of this research project indicates that further improvements in green manure and nitrogen fertilization in producing high cotton yield. It is interesting to note that green manure works quite well from the standpoint of nitrogen fertilization reducing, improvement of lint cotton yield. The maximum yield in this study was obtained from a combination of N and green manure applications, where yield increased (83.6, 73.15) % in both seasonal respectively from increasing N_0 application rate and without green manure (GM_0N_0) to 160 kg .$ha^{-1}$and Faba bean as green manure (GM_1N_{160}) .

All fresh and dry matter cotton plant parts (stems, leaves and fruiting forms) responses to green manure treatment significantly at flowering and maturity stage.

The N applications had significant effects on all fresh and dry matter cotton plant parts at flowering and maturity stage, and the best treatment gave the highest total fresh and dry matter was GM_1N_{240} in both seasonal. Data also indicated that interaction between GM and N was not significant on fresh and dry matter cotton plant parts at flowering and maturity stage and lint cotton yield.

In comparison with the usual cultural practices adopted by Al-Ghab plain conditions cotton producers, the combination of N, green manure treatments could improve cotton productivity and reduce ground water pollution by nitrate due to the production of organic N by manuring which is a slower release source of N compared with mineral N. Additional research is needed on N rates and green manure treatments to establish the optimal strategies for these production inputs.

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