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EFFECT OF SOME KINDS OF COVER CROPS ON YIELD AND FRUIT QUALITY OF KING RUBY GRAPEVINES

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ABSTRACT

This study was conducted for three successive seasons (2010, 2011 and 2012) on adult King Ruby grapevines at Baramon Horticulture Station, Dakahlia Governorate. The vines were ten-year-old, grown in a clay loamy soil and irrigated by flood irrigation system. Vines were planted at spaced 2 X 2.5 meters apart and trained as bilateral cordon system. Ammonium sulphate 20.6% was applied as source of mineral fertilization. Cover crops were planted among rows either Clover or Peas plants. Seven treatments of N units were applied as follows: 60 N-unit (Control), 60 N-unit + cover crop of Clover plants, 60 N-unit + cover crop of Peas plants, 45 N-unit + cover crop of Clover plants, 45 N-unit + cover crop of Peas plants, 30 N-unit + cover crop of Clover plants and 30 N-unit + cover crop of Peas plants.

The results showed that application of 60 N-unit with cover legumes crops either Clover or Peas plants were the best combined system, where they gave achieving the significant yield and its components. Also, they had significant of bunches, physical and chemical characteristics of berries, as well as nitrate and nitrite content of berries was decreased and best vegetative growth parameters and leaf mineral content of nitrogen, phosphorus and potassium of King Ruby grapevines were significant increased.

INTRODUCTION

Fertilization is one of the most important cultural practices carried out during the growing season, especially nitrogen fertilization. Nitrogen is one of the major plant nutrients, being a part of protein, enzymes, amino acids, polypeptides and many other biochemical compounds in plant system i.e. encouraging cell division and the development of meristeniatic tissue (Nijjar, 1985 and Mengel and Kirkby, 1987). Increasing nitrogen supply enhances photosynthesis which means that more sugar is available for growth and fruit quality (Keller, 2005). Excessive mineral nitrogen fertilization causes accumulation of harmful residual substances as nitrate and nitrite in berries and leaves of Grapevines (Montaser *et al*., 2003). Organic fertilizer is used to avoid harmful effects caused by synthetic fertilizers (De-Ell & Prange, 1993), they improve soil condition (Yagodin, 1984) and they are considered as important source of macro and micro nutrients (El-Haggar *et al.,* 2004).

Cover crops, especially legumes plants can provide multiple benefits in vineyard management (Miller *et al*., 1989). Some beneficial aspects of cover crops include: reduce soil erosion, improve soil structure, suppression of weed growth, increased water infiltration reduce ground water pollution and reduce sunburn of fruit (Miller *et al.,* 1989; Blake 1991; Louw & Bennie 1991; Gaffney & Van der Grinten 1991; Folorunso *at al.,* 1992; Smith 1993 and Gulick *et al.,* 1994). In addition, cover crops can provide N and increase availability of other nutrients in the soil (Miller *et al.,* 1989 and Rizk 2006). Today cover crops are applying in vineyards of Dakahlia governorate. There are benefits for growers, consumers and environment, where applied the system.

Both nitrate and nitrite are easily formed from excessive mineral nitrogen fertilization whereas it is slowly formed from organic nitrogen (Ibrahim, 1994). It is healthy to consume grape berries with lower nitrate and nitrite content. The acceptable daily intake (ADI) of nitrate and nitrite in the European countries which man can daily consume is 5 mg/kg, and 0.07 mg/kg respectively, of his weight (Abdel hameed, 1999).

Therefore, the objectives of this experiment were to determine the effects of N units fertilization and cover crops on vegetative growth, yield, berry composition and nutritional status of King Ruby grapevines under Dakahula governorate conditions.

MATERIAL AND METHODS

This study was conducted for three successive seasons (2010, 2011 and 2012) on adult King Ruby grapevines at Baramon Horticulture Station, Dakahlia Governorate. The chosen vines were ten-year-old, grown in a clay loamy soil and irrigated by flood irrigation system. Vines were spaced 2 X 2.5 meters apart and trained with bilateral cordon system. Pruning was carried out according to spurring pruned method and trellises on the telephone shape during the first week of March with bud load (45 bud/vine).

The soil sample was taken before planting legume crops in September to determine of physical and chemical properties of the soil as shown in Table (1).

Table (1): Physical and chemical properties of the experimental soil

Soil depth (cm)	pH	Ec	Available nutrients				Particle size distribution			
			N (ppm)	P (ppm)	K (ppm)	$CaCO_3$ (%)	Sand (%)	Silt (%)	Clay (%)	Texture
0-30	7.83	1.1	36	13.2	380	2.1	32.8	21.5	45.7	Clay loam
30-60	7.89	1.2	35	12.5	330	2.5	33.0	22.5	44.8	
60-90	8.00	1.4	33	11.9	325	3.0	33.5	23	43.5	

Note: The standard levels of soil

Element (ppm)	High	Middle	Low
N	>80	40-80	<40
P	>15	10-15	<10
K	>400	200-400	<200

Vines were fertilized with the rate of 60 units nitrogen/Feddan according to Rizk (2006). The units nitrogen of ammonium sulphate 20.6% as a source of mineral fertilization was added at three times:

25% was added at the beginning of bud burst, 50% after fruit set and 25% after harvest stage.

Cover crops were planted among rows either Clover (*Trifolium alexandrinum* L.) or Peas Cv. Master B (*Pisum sativum* L.) in October during three seasons of study (2009, 2010 and 2011).

Eighty four uniform vines were chosen, each four vines acted as a replicate including three replicates as follows:

1) 60 N-unit (Control)
2) 60 N-unit + cover crop of Clover plants
3) 60 N-unit + cover crop of Peas plants
4) 45 N-unit + cover crop of Clover plants
5) 45 N-unit + cover crop of Peas plants
6) 30 N-unit + cover crop of Clover plants
7) 30 N-unit + cover crop of Peas plants

A representative random sample of six bunches/vine were taken at maturity in 14 August, 9 August and 11 August in the three seasons of study (2009, 2010 and 2011) when SSC reached about 16-17% according to Tourky *et al*., (1995).

1. Yield (kg), bunch weight (g) and physical characteristics of berries were determined as berry weight (g) and size (cm^3).
2. Chemical characteristics of berries were determined as Soluble Solids Content in berry juice (S.S.C.) (%) by hand refractometer and acidity as tartaric acid (%) (A.O.A.C. 1985). Hence SSC/acid ratio and total anthocyanin of the berry skin (mg/g fresh weight) according to Husia et al., (1965). Berries content of nitrate (NO_3) and nitrite (NO_2) were determined according to Sen and Donaldson (1978).
3. Vegetative growth were determined like shoot length (cm) and number/vine, number of leaves/shoot and total leaves surface area/vine (m^2) was determined by multiplying average number of leaves/shoot by average of leaf surface area.
4. Leaf mineral content as total nitrogen (%), phosphorus (%) and potassium (%) were determined according to Pregl 1945, Snell and Snell 1967 and Jackson, 1967, respectively.

- **Statistical analysis:**

The complete randomized block design was adopted for the experiment. The statistical analysis of the data was carried out according to Snedecor and Cochran (1980). The averages were compared between them using the new L.S.D. values at 5% level.

RESULTS AND DISCUSSION

1. Yield, bunch weight and physical characteristics of berries:

Results presented in (Table 2) revealed that yield, bunch weight and physical characteristics of berries such as berry weight and size were significantly affected by tested treatments in the three seasons of this study. The data showed that vines receiving 60 unit mineral nitrogen fertilization with both cover crops plants on arranged Clover and Peas plants recorded significant increase on mentioned previous comparing with the other treatments. The vines that received 60 unit mineral nitrogen fertilization (control) gave significant increase as compared with T4, T5, T6 and T7 during the three seasons of the study, then vines that received 45 unit mineral nitrogen fertilization with both cover crops plants on arranged Clover and Peas plants. On the other hand, vines that received 30 unit mineral nitrogen fertilization with both cover crops plants on arranged Clover and Peas plants recorded the lowest values of yield, bunch weight and physical characteristics of berries.

Organic manure (as slow release for nitrogen) induced further reduction in No_3 accumulation in the plant compared with mineral nitrogen (as fast release for nitrogen) To attribute to the high available nitrogen release from the mineral fertilization, which increases the rate of nitrogen uptake by plant than its assimilation rate in plant cells in form No_3 or No_2 (El-Sisy, 2000).

These results are in harmony with those reported by Striegler *et al*., (1997) who mentioned that conventional cultural practices produced the highest yield of Thompson seedless grapevines. Similar results were observed by Rizk (2006) who found that conventional cultural practices (cultivation and mineral fertilization) significantly increased yield/vine, cluster weight and berries weight of Thompson seedless grapevines.

2. Chemical characteristics of berries:

As shown in (Table 3) berry chemical properties as soluble solids content, acidity, SSC/acid ratio, anthocyanin and nitrate and nitrite content of berries were significantly affected by fertilization treatments in the three seasons of this study. Each treatment of 60 N-units with both cover crops of Clover and Peas plants and 60 N-units (control) clearly significant increase on SSC%, SSC/acid ratio and anthocyanin of berry skin comparing with T4, T5, T6 and T7 during the three seasons of the study. In the contrary, they gave significant decrease in acidity of berries juice.

Keller *et al*., (1998) who confirmed that increasing nitrogen supply stimulates photosynthesis in leaves. Photosynthesis process use the energy from sunlight and transformed change into biochemical energy in form (ATP) which is used: to fix carbon dioxide (Co_2) and water (H_2o) to produce sugar (glucose), which means that more sugars are available for growth and fruit ripening.

Our data are in agreement with Rizk (2006) who found conventional cultural practices (cultivation and mineral fertilization) gave the highest significant increase of SSC %, SSC/acid ratio and lowest significant decrease of total acidity of Thompson seedless grapes.

With respect to berries content of nitrate and nitrite, it was obvious that berries content of nitrate and nitrite were significantly decrease by reducing of N-unit of mineral fertilization.

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The lowest values of nitrate and nitrite content in berries was obtained with vines that received 30 unit N-unit with both cover crops plants on arranged Clover and Peas plants followed in an ascending order by vines that received 45 N-unit with both cover crops plants on arranged Clover and Peas plants then 60 N-unit with both cover crops plants on arranged Clover and Peas plants. On the other hand, vines that received 60 N-unit (control) recorded significant increases in the three seasons as compare with other tested treatments under study.

Nitrate and nitrite are easily formed from mineral nitrogen fertilization (as fast release for nitrogen) whereas the use of organic nitrogen fertilization (as slow release for nitrogen) induced further reduction in No_3 accumulation in the plant (El-Sisy, 2000).

These results go in line with those of Omar (2005) who found that mineral nitrogen fertilization increased berry content of nitrate and values compared with compost or humic acid treatment of Thompson seedless grapes. Also, Rizk (2006) who found the highest nitrate and nitrite residues in the berries when fertilized with mineral nitrogen fertilization, whereas the lowest values were gained from compost with Peas or clover cover crop treatments.

3. Vegetative growth

Results presented in (Table 4) revealed that most of vegetative growth parameters (shoot length, number of leaves per shoot and total leaves surface area/vine) significantly affected by fertilization treatments in the three seasons of this study. Vines that received 60 N-unit with both cover crops plants of Clover and Peas plants recorded significant increase of previous parameters followed in a descending order 60 N-unit (control), 45 N-unit with both cover crops plants of Clover and Peas plants, respectively. On the other hand, 30 N-unit with both cover crops plants on arranged Clover and Peas plants recorded significant decrease during the three seasons of this study.

These results reveal that legume cover crops have the ability to symbiotically associate with certain soil microbial such as rhizobia has nitrogen fixation from atmospheric nitrogen (Chambliss et al, 2003). Mineral nitrogen is more effective in increasing leaf surface area than organic manures. This may be due to the higher availability of mineral nitrogen compared with organic plants (Omar, 2005). Yagodin (1984) found that No_3 is highly mobile in the soil, in contrast to organic fertilization, most of mineral fertilization are quick acting, which explains the effectiveness of mineral N in the short run while organic N acts in the long run.

The data go in line with those reported by Rizk (2006) who found that conventional cultural practices (cultivation and mineral fertilization) significantly increased average leaf surface area of Thompson seedless grapevines.

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4. Leaf petioles mineral content

As shown in (Table, 5), it is obvious that all leaf petioles content of total nitrogen, phosphorus and potassium were significantly affected by fertilization treatments in the three seasons of this study. It is apparent noticed that vines receiving 60 unit mineral nitrogen fertilization with both cover crops plants on arranged Clover and Peas plants recorded significant increase of NPK followed in a descending 60 unit mineral nitrogen fertilization (control) then 45 unit mineral nitrogen with both cover crops plants of Clover and Peas plants comparing with vines that received 30 unit mineral nitrogen with both cover crops plants of Clover and Peas plants in the three seasons of this study.

The improving effect of organic fertilization on leaf content of nitrogen as a result of legume plants have the ability to symbiotically associate with certain soil bacteria, rhizobia, that fix atmospheric nitrogen, they has normally high N content. The organic matter originating from legumes usually decomposes at a faster rate than grasses (Chambliss *et al*., 2003) As regarding effect of phosphorus and potassium in leaf petioles, phosphorus and potassium were increased by cover crops with mineral fertilization. This is not astonishing since, cover crops help bring-other nutrients back into the upper soil profile from deep soil layers. Potassium is a macronutrient which can be brought up from deeper soil layers by cover crop roots. The nutrients are then released back into the active organic matter when the cover crops decompose. Some cover crops are thought to secrete acids into the soil that put phosphorus into as more soluble plant — usable form. The roots of legume cover crops are house of beneficial fungi known as mycorrhizae. The mycorrhizae fungi have efficient means to release P from the soil, which they pass into their plant host keeping phosphorus in an organic form .This is the most efficient way to keep its cycling in the soil. Cover crops help retain P in the fields by reducing erosion. (Sarrantonio, 1989) .

The results in this respect agreement with Rizk (2006) who found that conventional cultural practices (cultivation and mineral fertilization) significantly increased mineral content in leaf petioles of Thompson seedless grapevines.

Some indicators of economic productivity of some nitrogen fertilization treatments on King Ruby grapes during the period (2010-2011-2012)

Table (6) indicate that the average yield of nitrogen fertilization treatments reached 18.55, 17.94, 16.47, 16.09, 15.11 and 14.97 tons respectively for the first, second, third, fourth, fifth and sixth treatment each of which represents approximately 117.43%, 113.52%, 104.22%, 101.84%, 95.63% and 94.75% respectively of the average farm yield per Feddan compared with 16.66 tons of the average farm productivity which means that, first, second, third and fourth treatments had excelled as a productive about 17.43%, 13.52%, 4.22% and 1.84% respectively while, the fifth and sixth treatments achieved a relative reduction amounting to 4.37% and 5.25% respectively.

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تأثير التحميل ببعض أنواع المحاصيل على المحصول وجودة الثمار لكرمات عنب الكنج روبى

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أجريت الدراسة خلال موسمي (٢٠١٠،٢٠١١، ٢٠١٢) على كرمات عنب صنف الكنج روبى المزروعة فى محطة بحوث البساتين بالبرامون – التابعة لمحافظة الدقهلية. وكانت عمر الكرمات عشرة سنوات، نامية فى تربة طينية طميية وتروى بنظام الرى بالغمر، وكانت مسافات الزراعة ٢.٥X٢ متر ومرباة بنظام الكردون الثنائى. استعملت سماد سلفات النشادر (٢٠.٦%) مصدر للتسميد النيتروجينى المعدنى، بينما تمثلت محاصيل التحميل فى محصولى البرسيم أو البسلة. وقد تم إجراء سبعة معاملات وهى ٦٠ وحدة نيتروجين معدنى (كنترول)، ٦٠ وحدة نيتروجين معدنى + التحميل بمحصول البرسيم، ٦٠ وحدة نيتروجين معدنى + التحميل بمحصول البسلة، ٤٥ وحدة نيتروجين معدنى + التحميل بمحصول البرسيم، ٤٥ وحدة نيتروجين معدنى + التحميل بمحصول البسلة، ٣٠ وحدة نيتروجين معدنى + التحميل بمحصول البرسيم، ٣٠ وحدة نيتروجين معدنى + التحميل بمحصول البسلة.

أشارت نتائج الدراسة إلى أن إضافة ٦٠ وحدة نيتروجين معدنى مع التحميل بكل من البرسيم أو البسلة أعطت أفضل نظام إدارة فى الحصول على أعلى محصول ومكوناته بالاضافة إلى تحسين الصفات الطبيعية والكيماوية للحبات، تقليل محتوى الحبات من النترات والنيتريت مع الحصول على أفضل قياسات خضرية فى المساحة الورقية مع زيادة المحتوى المعدنى لأعناق الأوراق من النيتروجين والفوسفور والبوتاسيوم لكرمات عنب الكنج الروبى.

قام بتحكيم البحث

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Table (2):Effect of mineral nitrogen fertilization and cover crops on yield/vine and physical characteristics of bunches and berries in King Ruby grapevines in 2010, 2011 and 2012 seasons

Characteristics	Yield/vine (kg)			Average bunch weight (g)			Average berry weight (g)			Average berry size (cm^3)		
Treatments	2010	2011	2012	2010	2011	2012	2010	2011	2012	2010	2011	2012
60 N-unit (Control)	16.37	16.71	16.91	590.1	605.8	592.5	2.65	2.63	2.64	2.33	2.31	2.32
60 N-unit + cover crop of Clover plants	18.33	18.64	18.69	640.7	685.9	683.4	2.80	2.87	2.86	2.46	2.53	2.52
60 N-unit + cover crop of Peas plants	18.09	17.89	17.83	630.5	620.4	644.2	2.73	2.82	2.83	2.40	2.48	2.49
45 N-unit + cover crop of Clover plants	16.34	16.39	16.67	525.3	575.6	566.1	2.63	2.62	2.63	2.31	2.31	2.31
45 N-unit + cover crop of Peas plants	15.63	16.32	16.32	508.4	533.1	561.4	2.45	2.52	2.54	2.16	2.22	2.24
30 N-unit + cover crop of Clover plants	14.58	15.38	15.37	420.8	490.7	507.9	2.41	2.43	2.42	2.12	2.14	2.13
30 N-unit + cover crop of Peas plants	14.27	15.31	15.33	411.9	421.9	468.3	2.32	2.35	2.31	2.04	2.07	2.03
new L.S.D. at 0.05 =	0.21	0.67	0.74	9.1	58.3	34.9	0.06	0.04	0.02	0.05	0.03	0.02

Table (3): Effect of mineral nitrogen fertilization and cover crops on chemical characteristics of berries in King Ruby grapevines in 2010, 2011 and 2012 seasons

Characteristics / Treatments	SSC (%)			Acidity (%)			SSC/acid ratio			Total anthocyanin (mg/g F.W.)			Nitrate (ppm F.W.)			Nitrite (ppm F.W.)		
	2010	2011	2012	2010	2011	2012	2010	2011	2012	2010	2011	2012	2010	2011	2012	2010	2011	2012
60 N-unit (Control)	16.4	16.8	16.6	0.57	0.53	0.54	28.8	31.7	30.7	0.81	0.81	0.82	5.87	5.91	5.93	1.02	1.04	1.03
60 N-unit + cover crop of Clover plants	16.7	17.0	16.9	0.54	0.50	0.51	30.9	34.0	33.1	0.91	0.95	0.94	5.02	4.93	4.81	0.91	0.90	0.89
60 N-unit + cover crop of Peas plants	16.5	16.9	16.7	0.55	0.52	0.52	30.0	32.5	32.1	0.86	0.84	0.85	5.11	4.97	4.92	0.93	0.91	0.90
45 N-unit + cover crop of Clover plants	16.3	16.6	16.5	0.57	0.54	0.55	28.6	30.7	30.0	0.75	0.74	0.78	4.01	4.21	3.45	0.82	0.81	0.82
45 N-unit + cover crop of Peas plants	16.1	16.4	16.3	0.59	0.55	0.56	27.3	29.8	29.1	0.70	0.71	0.70	4.03	4.43	4.05	0.85	0.84	0.86
30 N-unit + cover crop of Clover plants	15.9	16.3	16.2	0.60	0.56	0.58	26.5	29.1	27.9	0.68	0.69	0.68	2.64	2.07	2.04	0.66	0.73	0.71
30 N-unit + cover crop of Peas plants	15.8	16.2	16.0	0.61	0.58	0.59	25.9	27.9	27.1	0.63	0.66	0.67	3.16	2.47	2.07	0.71	0.76	0.74
new L.S.D. at 0.05 =	0.2	0.1	0.2	0.01	0.02	0.02	0.92	1.19	0.97	0.04	0.09	0.07	0.73	0.89	0.97	0.08	0.11	0.09

Table (4): Effect of mineral nitrogen fertilization and cover crops on morphological characteristics of vegetative growth in King Ruby grapevines in 2010, 2011 and 2012 seasons

Characteristics / Treatments	Average shoot length (cm)			No. of leaves/shoot			Total leaf surface area/vine (m^2)		
	2010	**2011**	**2012**	**2010**	**2011**	**2012**	**2010**	**2011**	**2012**
60 N-unit (Control)	164.8	171.7	177.5	28.9	29.5	30.8	26.9	28.7	30.9
60 N-unit + cover crop of Clover plants	168.2	175.5	181.1	29.8	31.3	32.3	28.3	30.8	32.7
60 N-unit + cover crop of Peas plants	167.1	174.2	179.9	29.1	30.5	31.6	27.5	30.2	32.3
45 N-unit + cover crop of Clover plants	163.5	170.2	176.1	28.3	29.3	30.6	26.4	28.1	30.4
45 N-unit + cover crop of Peas plants	161.2	167.7	173.7	27.6	28.7	30.1	26.1	27.4	30.1
30 N-unit + cover crop of Clover plants	159.9	166.2	172.3	27.0	28.0	29.5	24.3	25.7	26.4
30 N-unit + cover crop of Peas plants	157.6	163.7	169.9	27.0	27.3	28.9	23.8	25.4	25.9
new L.S.D. at 0.05 =	0.9	1.1	1.7	0.6	0.7	0.6	0.5	0.6	0.4

Table (5):Effect of mineral nitrogen fertilization and cover crops on mineral content in King Ruby grapevines in 2010, 2011 and 2012 seasons

Characteristics / Treatments	Leaf nitrogen content (%)			Leaf phosphorus content (%)			Leaf potassium content (%)		
	2010	2011	2012	2010	2011	2012	2010	2011	2012
60 N-unit (Control)	2.83	3.17	3.03	0.23	0.26	0.25	1.90	1.98	2.01
60 N-unit + cover crop of Clover plants	3.12	3.44	3.24	0.26	0.29	0.27	1.95	2.02	2.06
60 N-unit + cover crop of Peas plants	2.89	3.34	3.19	0.24	0.28	0.26	1.92	1.99	2.03
45 N-unit + cover crop of Clover plants	2.81	3.04	2.95	0.22	0.25	0.24	1.87	1.92	1.96
45 N-unit + cover crop of Peas plants	2.74	2.96	2.84	0.21	0.24	0.22	1.86	1.92	1.95
30 N-unit + cover crop of Clover plants	2.59	2.67	2.64	0.19	0.23	0.20	1.83	1.90	1.94
30 N-unit + cover crop of Peas plants	2.53	2.61	2.59	0.18	0.21	0.19	1.82	1.88	1.93
new L.S.D. at 0.05 =	0.27	0.21	0.18	0.02	0.01	0.02	0.04	0.03	0.04

Table (6): Some indicators of economic productivity of some nitrogen fertilization treatments on King Ruby grapes during the period(2010-2011-2012)

Statement / Treatments	Feddan productivity		Total revenue		(1) - (2)	Net revenue tons fertilization of control
	Tons	Total figure (%)	F/pound (1)	F/pound (2)		
60 N-unit (Control)	16.66	100	1666	900	766	-
60 N-unit + cover crop of Clover plants	18.55	117.43	1855	900	955	275
60 N-unit + cover crop of Peas plants	17.94	113.52	1794	900	894	214
45 N-unit + cover crop of Clover plants	16.47	104.22	1647	600	1047	367
45 N-unit + cover crop of Peas plants	16.09	101.84	1609	600	1009	329
30 N-unit + cover crop of Clover plants	15.11	95.63	1511	450	1061	381
30 N-unit + cover crop of Peas plants	14.97	94.75	1497	450	1047	367