THE ROLE OF BROAD BEAN AND ONOION INTERCROPPING ON PRODUCTIVITY OF BOTH CROPS AND NITROGEN BUDGET IN SOIL

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ABSTRACT

A field experiment was conducted at the College of Physical Education & Sport Science-University of Baghdad /Jaderiea fields at 2015-2016 season, to study the effect of planting Broad bean and onion either in monoculture or intercropped (bicultural) interacted with three levels of nitrogen (0,40,and 80 kg N ha^{-1}) on growth and productivity of both crops ,amount of N taken up and on nitrogen budget in a split plot experiment within RCBD in three replicates . Nitrogen application especially 2nd level (80 kg N ha^{-1}) significantly increased growth and yield of Broad bean . Yield of fresh pods increased from 1.36 kg $plant^{-1}$ at control to 1.74 kg $plant^{-1}$ with N_2. Nitrogen application at 80 kg N ha^{-1} increased the uptake (content) of nitrogen by 245.11% compared to control. Nitrogen application especially 2nd level (80 kg N ha^{-1}) significantly increased growth and yield of Onion. Fresh weight of onion bulbs increased from 27.3 to 37.2 and dry weight from 17.8 to 22.8 g $plant^{-1}$ due to the application of the 2nd level of nitrogen. Nitrogen application at 80 kg N ha^{-1} increased the uptake (content) of nitrogen in onion. Planting Broad bean in monoculture gave better results than bicultural with Onion. However, yield of Broad bean was reasonable in both cultures due to the ability of Broad bean crop for competition with Onion. Monoculture of Onion gave better results than bicultural. In spite of the low production of Onion in bicultural but two crops can be gained at the same field. Results of nitrogen budget revealed that the budget was surplus with Broad bean as a result of N fixation and in shortage with Onion.

Key words: mono and bicultural-intercropped, Broad bean and Onion productivity, N-Budget .
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دور الزراعة المتداخلة للباقلاء والبصل في إنتاجية المحصولين وميزانية النتروجين في التربة

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المستخلص

أجريت تجربة حقلية في حقول كلية التربية الرياضية – جامعة بغداد / في منطقة الجادرية خلال الموسم الزراعي 2015–2016 لدراسة تأثير نوع الزراعة (أحادية أو ثنائية – متداخلة) و ثلاثة مستويات من النتروجين (0 – 40 –80 كغمNهـ$^{-1}$) والتداخل بينهما في بعض معايير نمو وأنتاجية كل من الباقلاء والبصل وفي كميات النتروجين الممتصة من المحصولين وفي ميزانية النتروجين في تجربة الواح منشقة ضمن RCBD. حقق المستوى الثاني من النتروجين (كغمNهـ$^{-1}$) زيادة في الوزن الرطب للقرنات الى 1.74 كغم نبات$^{-1}$ بالقياس الى 1.36 كغم نبات$^{-1}$ لمعاملة المقارنة (عدم الإضافة). وأدى التسميد بهذا المستوى الى زيادة في محتوى نبات الباقلاء من النتروجين بنسبة زيادة 245.11 بالقياس الى معاملة عدم الإضافة . وزاد التسميد النتروجيني من الوزنين الرطب والجاف للابصال إذ أزداد الوزن من 27.3 الى 37.2 ومن 17.8 الى 22.8 غم نبات$^{-1}$ ، للوزنين الرطب والجاف بالترتيب وزاد من محتوى النتروجين في الابصال .الزراعة المنفردة للباقلاء والبصل حققت نتائج افضل من الزراعة الثنائية الا ان الباقلاء حقق نتائج جيدة حتى في الزراعة الثنائية . بينت ميزانية النتروجين وجود زيادة في الميزانية مع محصول الباقلاء وعجز مع محصول البصل.

الكلمات المفتاحية : زراعة احادية وثنائية متداخلة ،أنتاجية الباقلاء وإنتاجية البصل وميزانية النتروجين .
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INTRODUCTION

The Decrease in soil fertility in most Iraqi agricultural farms especially in the middle and south of Iraq can be attributed mainly to lack or shortage of nitrogen. The instability of Iraqi weather conditions and its calcareous soil affected negatively on soil organic carbon (SOC) and on soil nitrogen .Therefore, nitrogen management and nitrogen fertilization can be consider as one of the main best management practices (BMP) for nitrogen use efficiency improvement, and good practices were used to achieve this economically and environmentally goal(3) . Intercropping (bicultural)as an old and new agriculture system can be consider as a way to crop two or more crops either at the same time or in sequence on the same line or at alternative or opposite lines at the same piece of land . Generally one of the crops should be legume for a better and best use for resources compared to monoculture (10, 22). Nitrogen as a nutrient can be considered as the most essential nutrient for –plants and other organisms. Nitrogen can be considered as peculiar due to biochemical transformations and cycling from one phase to another and its losses through gases and leaching (3).Therefore, the study of its inputs and outputs (i.e. nitrogen balance) one of the important topic to be investigated in soil fertility in mono and multi cultural cropping system for good economic retains and safe environment (15). The objective of this research was to investigate the role of bicultural cropping and rate of nitrogen fertilizers application on nitrogen balance in a calcareous Iraqi soil.

METERIALS AND METHODS

Field experiment was conducted at a loamy soil (Table 1) at a field located at the college of physical and sports education, University of Baghdad, Aljaderia at 2015-2016 seasons. The study aimed to investigate the role of intercropping (mono or bicultural) and nitrogen fertilizer rate of application (0,40,and 80 kg N ha^{-1}) and their interactions on some growth and yield parameters of onion and broad bean and on amount of N taken up by plants and N balance in soil in a spilt plot in RCBD arrangement in 3 replicates .intercropping represent the main plot (broad bean "B" and Onion "O" or broad bean+ onion "BO") and N rates the sub plots .Land was divided to experimental units (12 m^2 for each) After land preparations and enough spaces were lifted to overcome nutrient movement among plots .Broad bean (*Vicia faba*)seeds Loz de Otono variety were planted in holes 0.3 m apart. Onion (*Lilium cepa*) Texas Early Grano 502 seedlings were prepared before hand and transplanted in the permanent field either alone in 0.1 m apart or in intercropped with broad bean at the same lines. The field was irrigated through drip irrigation system arranged in an efficient way on the field. After land preparation all experimental field received liquid organic fertilizer through drip system to improve soil chemical, physical and biological properties .Urea fertilizer was applied after planting of both crops in two splits. All Phosphorus and potassium fertilizers were applied with the first part of N application in an amount depended on soil analysis (4). 20 random pods were taken from each experimental unit at the maturity stage for fresh and dry weight for broad bean pod yield .5 plants were taken for fresh and dry weight of broad bean plants (7). 10 onion plants were taken for top and bulb yield measurements (6). All soil chemical, physical and biological analyses were conducted according to standard methods cited (9,18,21).All plant material analyses were done according to methods mentioned in Haynes (13). Ammonia volatilization in the field was measured according to method modified from laboratory method (21) by authors. Nitrogen test indicators (Boric acid, Methyl red and Bromocresol green) were put in a baker to captured ammonia and for analysis. These bakers were driven(placed) in different places in the field and covered by suitable cover. After a proper time ammonia was collected and taken to the laboratory for determination. Ammonia volatilized was calculated according to the following formula

NH_3 –N volatilize = Volume of consumed acid x *N* x14x100/ amount of nitrogen applied x1000

Table 1. Soil chemical, physical and biological properties of the soil before planting

Properties		Amount	unit
pH		7.35	-
EC(1:1)		1.2	dSm^{-1}
SOM		7.6	$gm\ kg^{-1}soil$
CEC		21.47	$Cmol_{+}kg^{-1}$ soil
Total N		0.18	%
	N	43.0	
Available	P	10.1	$mg\ kg^{-1}$ soil
	K	200.0	
Texture		loam	
Total bacteria		6.2×10^5	CFU gm^{-1} dry soil
Total Fungi		3.1×10^4	

RESULTS AND DISCUSSION

Rates of N fertilizers affected on dry matter yield of broad bean with N_2 (80 kg N ha^{-1}) giving dry weight of 297.33 gm dry Wt. $plant^{-1}$ with an increment of 43.41% than N_0(0 kg N ha^{-1}) which had 207.3 gm dry Wt. $plant^{-1}$(Table 2). Monoculture of broad bean (B) gave 336.3 gm dry Wt. $plant^{-1}$ and was better with an increment of 109.5 % than bicultural (Intercropped) (B_O) .Results of Table 2 indicated that the interaction between level of N and intercropping was significant with N_2B being the best treatment in dry matter yield of broad bean with an increment of 203.5% than N_0Bo.Levels of N did not had an effect on fresh weight of pods while monoculture of broad bean was superior with 33.3% increment than bicultural (Table 2). The second rate of N_2 (80 kg N ha^{-1}) gave better pod dry matter with an increment of 39.65% than N_0.Monoculture of broad bean (B) was better with an increment of 26.83% compared to bicultural (Bo) of broad bean and onion .The response to N fertilizer especially N_2 can be due to the role of N in growth of plants (8) especially with soil with low available N and low SOM (Table 1). These results are at a similar trend with results of other researchers (20, 22). Results of intercropping disagree with Mahdi *et al.*, (17) who indicated that yield of broad bean pods was better in intercropping with garlic and onion, due to different management between their experiment and our experiment. They grow broad bean and garlic in parallel lines while in our experiment at the same line. The importance of N application in intercropping agriculture is in agreement with intercropping in other crops including legumes (5, 19).

Table 2. The effect of Intercropping and N rates on dry matter yield of plants, fresh and dry weight of broad bean pods ($gm\ plant^{-1}$)

Kind of cropping	Dry matter Yield of Vegetative parts			X	Fresh Wt. of Pods			X	Dry Wt. of Pods			X
	Rates of nitrogen (N)				Rates of nitrogen (N)				Rates of nitrogen (N)			
	N_0	N_1	N_2		N_0	N_1	N_2		N_0	N_1	N_2	
B	281.3	323.0	404.7	336.3	1631.7	1639.1	1968.4	1744.3	224.1	231.0	293.7	249.6
Bo	133.3	158.3	90.01	160.6	1098.5	1321.0	1515.4	1308.9	156.7	195.5	238.1	196.8
X	207.3	240.7	297.3	-	1355.5	1476.2	1737.0		190.4	213.2	265.9	
LSD 0.05	N rates =9.652 Intercropped=7.881 Interaction =11.873				N rates =289.41 Intercropped=110.3 Interaction=522.7				N rates =22.40 Intercropped=18.40 Interaction=27.6			

Nitrogen taken up by vegetative parts increased with N application especially N_2 giving 5379.1 mg N $plant^{-1}$ with an increment of 114.14% than No which had 2512.0 mg N $plant^{-1}$ (Table 3). Monoculture of broad bean alone (B)absorbed 5478.1 mg N $plant^{-1}$with an increment of 158.18% than intercropped of broad bean with onion (Bo). The highest N content was with the treatment of BN_2 with an increment of 430.63% compared to BoN_0. Abou-Amer (2) indicated that application of NPK fertilizer to broad bean improved its growth, nutrient contents and fruit quality. The same results were observed with N content in broad bean pods with N_2 giving the best results (Table 3). Broad bean grown alone gave better N content than intercropped broad bean .The best treatment in N content was BN_2 with an increment of 716.02% compared to BoN_0(Table 3).The increment of N content in broad bean reflect the fact that Pods and grains are the final sink for nutrients absorbed by

plants (11). Although broad bean is one of the legumes and field and laboratory tests proved the activeness of rhizobia in fixing atmospheric nitrogen (12) there was a response to the second level of N (80 kg N ha^{-1}) especially with intercropping as mentioned above .These results are in agreement with Li *et al.*, (16) who indicated the role of N fertilizer in intercropping .The success of intercropping at the same piece of land at the same row of planting depends on soil and crops (1, 25).

Table 3. The effect of Intercropping and N rates on N taken up (content) by vegetative parts and pods of broad bean (mg N $plant^{-1}$)

Kind of cropping	N taken up by Vegetative parts			X	N taken up by Pods			X
	Rates of nitrogen (N)				Rates of nitrogen (N)			
	N_0	N_1	N_2		N_0	N_1	N_2	
B	3544.4	5038.8	7851.2	5478.1	2711.0	5312.5	14452.0	7491.8
Bo	1479.6	1978.8	2907.0	2121.8	1770.9	3655.5	8667.2	4697.9
X	2512.0	3508.8	5379.1	-	2241.0	4484.0	11559.6	-
LSD 0.05	N rates =393.0 Intercropped=320.9 Interaction =901.3				N rates =1446.8 Intercropped=1181.3 Interaction=1826.1			-

Effects of Kind of cropping and level of nitrogen on dry weight of leaves, fresh and dry weight of onion bulbs are presented at table 4.The highest dry matter of onion leaves was with N_2 with 40.0 gm $plant^{-1}$ with 44.6% increment than N_0. Monoculture of onion (O) was better with an increment of 68.8% compared to bicultural (O_B) of onion and broad bean .The highest leaves dry weight occurred with ON_2 treatment. Similar trend for the effects of nitrogen application and intercropping were observed on fresh and dry weight of onion bulbs. The best results were with N application (N_1 and N_2) and monoculture of onion compared to N_0 and bicultural with broad bean (Table 4).These results are in some way in agreement with Toaima (24), results.

Table 4. The effect of Intercropping and N rates on dry weight of onion leaves, fresh and dry weight of onion bulbs (gm)

Kind of cropping	Dry Wt. of leaves(gm $plant^{-1}$)			X	Fresh Wt. of bulbs(gm $bulb^{-1}$)			X	Dry Wt. of bulbs(gm $bulb^{-1}$)			X
	Rates of nitrogen (N)				Rates of nitrogen (N)				Rates of nitrogen (N)			
	N_0	N_1	N_2		N_0	N_1	N_2		N_0	N_1	N_2	
O	35.00	41.67	53.33	43.33	43.00	55.00	60.00	52.67	26.67	32.33	35.00	31.33
O_B	20.33	30.00	26.67	25.67	11.67	13.33	14.33	13.11	9.00	10.33	10.67	10.00
X	27.67	35.83	40.00	-	27.33	34.17	37.17	-	17.83	21.33	22.83	-
LSD 0.05	N rates =4.1926 Intercropped=3.4232 Interaction =5.199				N rates =2.093 Intercropped=1.709 Interaction=3.382				N rates =4.1749 Intercropped=3.4088 Interaction=5.1349			

Amounts of nitrogen taken up by onion leaves and bulbs indicated that the second level of nitrogen (N_2) and monoculture of onion (O) gave the highest amount of nitrogen (Table 5).The highest treatment in N content was ON_2.Results of our experiment indicated that broad bean competed onion due to the large size of broad bean plants and cropping at the same line (furrow). These results in agreement with other researchers who indicated that beet root competed onion(1,24).However , the importance of onion and garlic in bicultural was indicated in some literatures especially in overcoming some diseases (15) but should be planted in other crops than broad bean or in lines alone . Results mentioned above reveled that two crops can be grown at the same field and the risk of growing one crop cal be eliminated.

Table 5. The effect of Intercropping and N rates on N content in leaves and onion bulbs (mg N plant^{-1})

Kind of cropping	N content in leaves			X	N content in bulbs			X
	Rates of nitrogen (N)				Rates of nitrogen (N)			
	N_0	N_1	N_2		N_0	N_1	N_2	
O	266.0	425.0	650.6	447.2	245.4	394.4	511.0	383.6
O_B	142.3	282.0	314.7	246.3	77.4	118.8	145.1	113.8
X	204.2	353.5	482.7		161.4	256.6	328.1	
LSD 0.05	N rates =36.53 Intercropped=29.82 Interaction =51.30				N rates =53.51 Intercropped=43.69 Interaction=70.02			

Results of ammonia volatilization from trial field indicated that the highest amount of ammonia lost was with N2 and onion alone (O),compared to intercropped of broad bean and onion (BO) with N_1(Table 6).The loss of N through volatilization can be related to the nature of the soil (Table 1) and the cover crop and environmental conditions (3).The amount N lost in this experiment (Table 6) still reasonable compared to results of other researchers (23) due to proper management used especially irrigation (drip irrigation) , and method of N application .

Table 6 . The effect of Intercropping and N rates on ammonia (kg NH_3-N ha^{-1})

Kind of cropping	Rates of nitrogen (N)		X
	N_1	N_2	
Broad bean (B)	7.419	8.528	7.974
Onion (O)	7.211	9.360	8.286
Onion+ Broad bean (BO)	6.587	7.800	7.194
X	7.072	8.563	
$LSD_{0.05}$ OB = 0.7198 N = 0.5877 OB×N = 0.8641			

Table 7. Nitrogen Budget (N Balance) (kg N ha^{-1})

Treatment	Inputs			outputs			Budget
	Soil N (original)	N applied	Sum	N uptake	N volatilize	sum	
N_1B	86.0	40.0	126.0	225.1	7.0	232.1	+
N_1B_o	86.0	40.0	126.0	90.2	6.6	96.8	-
N_2B	86.0	80.0	166.0	347.0	8.5	355.5	+
$N_2 B_o$	86.0	80.0	166.0	131.0	7.8	138.8	-
N_1O	86.0	40.0	126.0	68.3	7.0	75.3	-
N_1O_B	86.0	40.0	126.0	16.0	6.6	22.6	-
N_2O	86.0	80.0	166.0	96.8	8.5	105.3	-
N_2O_B	86.0	80.0	166.0	18.4	7.8	26.2	-
N_1=40 kg N ha^{-1}, N2=80kgNha^{-1}, B=Broad bean, B_O=intercropped bean), O=Onion), O_B=Intercropped Onion. Budget : + = surplus ,- = deficit							

volatilized from field

Results of N balance or N budget (input and output) are presented at table 7. It can be seen from table 7 that broad bean grown alone or in intercropping had surplus of nitrogen due to N fixation (12).In Onion system the outputs were smaller than the inputs which indicated deficit.

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