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ORIGINAL ARTICLE

Combinational Effects of Green Manure and Chemical Fertilizer on Economic Yield of Growing Wheat in Subtropical Conditions of Khuzestan

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ABSTRACT
Increased soil organic matter increases the sustainability of production in wheat cultivation systems. To study the effect of chemical fertilizers and green manure on the yield and as a result, the economic profit of wheat cultivation, an experiment was done in 3 crop years2009-2012 in the agricultural land in the North of Khuzestan. The study was conducted as factorial split plot test in a complete randomized block design with three replications. Two planting dates of Vigna radiata green manure and fallow plots were considered as main plots. Three levels of nitrogen fertilizer were placed in subplots as the first factor and three levels of phosphorus fertilizer as second factor. Planting Vigna Radiata as green manure increased organic matter and minerals in the soil. The effect of green manure and interaction of experimental treatments was significant on grain yield at 5% probability and the effect of phosphorus and nitrogen on this trait at 1% level. Delay in planting Vigna radiata green manure reduces its beneficial effects on grain yield. The maximum grain yield belongs to treatment 120 kg N +90 kg phosphorus in planting green manure on 3th July. Planting Vigna Radiatato use as green manure on 3th July increased the wheat seed yield compared to fallow conditions. Increased grain yield in green manure treatments compared to fallow was due to the increased number of seeds per plant and biological yield. The maximum economic benefit was related to treatment 120 kgN + 90 kg phosphorus in planting date of 3th July.
Keywords*: wheat, fertilizer, economic yield, performance*

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INTRODUCTION

Today, the use of low-input farming systems and inventing new methods of managing resource exploitation is particularly important to achieve the objectives of sustainable agriculture. The use of bio and green fertilizers is an important issue in moving towards sustainable agriculture to reduce the consumption of chemical fertilizers and increase the performance of plants. Farmers continued use of soil reduces the amount of its organic matter. Many researchers have suggested that the cultivation and use of plants as green manure in autumn causes mineral nitrogen in organic matters and thus reduced nitrate leaching [1]. One of the major problems facing agriculture today is reducing the amount of humus and soil quality which is associated with reducing organic carbon and total nitrogen in soil [2]. The use of chemical fertilizers is increasing all over the world for production that its continuous use will cause serious risks to human health and the environment [3]. The use of legume crops in alternation with other crops and cereals may be one of the methods in reducing the use of chemical fertilizers [4].Pokurna [5] reported that continuous and excessive use of common chemical fertilizers can significantly reduce the bacterial activity and soil fertility. On the other hand, continuous cultivation of crops reduces gradually the soil nutrient, so for economical harvest, the necessary nutrients as well as soil physical conditions should be maintained at the appropriate level.

In general, the economic and efficient use of natural resources in agricultural systems is very useful [6]. Wheat is an important crop that one of the most important aspects in its agriculture is the use of fertilizers [7]. The use of organic fertilizers can be a good alternative to chemical ones. Qorbani *et al.*, [8] The use of some crops as green manure increases the culture system stability by reducing soil erosion, controlling weeds, increasing organic matters and soil fertilization . Green manure is considered as a soil restoration or a food source for plant [9]. Phosphorus in organic compounds of green plants provides an absorbable and changeable form for the next plant. Organic phosphorus is converted gradually to inorganic phosphorus through mineralization and is absorbed by the next crop. It is reported that green manure increased the percentage of organic matter, microorganism biomass, soil dehydrogenase and urease compared to the control without fertilizer [10]. Shah et al., [11] reported in a multi-year research that alternative crop of legume family plants as green manure and wheat with the use of nitrogen fertilizer increase the efficiency of nutrient absorption.

Although, the use of green fertilizers is effective in providing nutrients and improving soil properties, but it should be noted that these fertilizers are not able to provide all the needed nutrients. Therefore, it seems that combining these fertilizers with reduced levels of mineral fertilizers, in addition to meeting nutritional needs of the plant, increases soil organic matter and chemical and physical quality of it. *Vigna radiata* is one of the crops of legume family that can stabilize the nitrogen biologically and in some tropical and semitropical areas is cultured as green manure. Little research has been done in the country and Khuzestanon the impact of culturing this plant as a green manure as well as its interaction with different levels of mineral nitrogen and phosphorus on soil properties as well as yield and components of wheat seed yield. The present study was done to evaluate the effect of *Vigna radiata* planting date as green manure and different levels of phosphorus and nitrogen fertilizers on wheat grain yield and its components in environmental conditions of north of Khuzestan.

MATERIALS AND METHODS

The experiment was done in 3 crop years2009-2012 in the agricultural land in the North of Khuzestan. The experiment site was at latitude 32°36´ N and longitude 48°31´ E and is about 143 m above the sea level. It had hot dry climate with mild winters and hot dry summers.

It was a factorial split plot experiment with three replications. The main plot included two sowing dates of green manure of the mung bean (July 3, August 10) and the fallow conditions. The sub plot included three levels of nitrogen fertilizer (without fertilizer, 60, and 120 kg/ha nitrogen) as the first factor and three levels of phosphorus fertilizer (without fertilizer, 45, and 90 kg/ha phosphorus) as the second factor. Land preparation operations for mung bean cultivation included deep plowing, two perpendicular discs and trowel. In the mid flowering stage the mung bean was returned to the soil by plowing and it was well crushed and mixed with the soil by rotavator. Land preparation operations for the wheat (Chamran cultivar) included deep plowing, two perpendicular disks and trowel. The density of cultivated wheat seeds according to the research recommendations was 400 seeds per square meter. The weal was sowed in December 6. The amount of consumed mung bean seed was 100 kg/ha. Nitrogen fertilizer form the urea source and phosphorus from the triple super phosphate source were added to the soil according to the amount of fertilizer treatment. Half of nitrogen fertilizer and all the phosphorus fertilizer were distributed in the field as the base after the first disc and were mixed with soil by the second disk. The second half of nitrogen fertilizer in each treatment was used at stem elongation stage as top dressing. Some features of the soil such as the content of organic matter, phosphorus, nitrogen, potassium, acidity and the soil texture were measured in two depths of 0-30 cm and 30-60 cm before and after using the green manure.

In order to determine the grain yield and yield components, the grains were harvested at the final maturity stage and after the removal of half a meter of the beginning and end of each plot in lines 3 and 4 in an area of 1.2 m2. The weight of the seeds was calculated in four 250-seed samples. The data were analyzed by means of SAS statistical program and the means were compared via Duncan's multi range test at 5% level. In order to draw the diagrams, Excel software was used.

RESULTS AND DISCUSSION

Soil properties

Results related to the amount of organic matter of soil and phosphorus, potassium and nitrogen before and after the return of green manure and before planting wheat is given in the table.Mandel et al., (2003) concluded that when using *Vigna radiata* green manure, improving soil structure, increasing the amount of organic matter and increasing nitrogen levels in the soil increased wheat seed yield. [12].Planting *Vigna radiata* on 3th July increases the duration of the growth phase of the plant to be used as a green

manure and this partly leads to an increase in the plant biomass at the time of turning to soil.(Table 2) On the other hand, the flowering stage in the early sowing of *Vigna radiata* occurred sooner. Therefore, in this planting date, time gap between the use of green manure and planting wheat was more. It seems that this provides enough time for the disintegration of organic matter and releasing elements of the nutrients in this treatment.

Table (1): Some of the feature of the soil in mung bean planting treatments as the green manure and fallow before planting the wheat

experiment options			E.C 10^3	pH p.p.m	O.C %	s.p %	Pava p.p.m	Kava p.p.m	N.tot p.p.m	NH_4 p.p.m	NO_3 p.p.m
green manures **before plantation**											
Sample depth	0-30		0.92	7.9	0.60	32.0	6.8	188	660	17.4	28.9
	30-60		0.50	8.10	0.34	30.5	3.4	69	460	13.7	14.5
Before planting wheat											
3 july	Sample depth	0-30	0.60	8.04	0.72	31.5	6.5	178	680	20.8	27.8
		30-60	0.50	8. 09	0.36	32.3	4	77	500	14.5	17.8
10August		0-30	0.65	7.92	0.70	31.1	7	159	620	17.4	27.3
		30-60	0.45	8.15	0.36	29.7	4.2	86	380	13.7	14.5

Table (2):Bio-mass and dry weight of the vetch in different planting dates

Planting dates	Weight vetch(g/m^2)	Dry weight vetch(g/m^2)
3 July	**4135**	**833**
10August	**4045**	**811**

Grain yield and its related traits

Results showed that the effect of green manure treatment and interactions of phosphorus, nitrogen and green manure on spike per square meter at 5% probability level and the effect of phosphorus and nitrogen fertilizers on this trait at 1%probability level was significant. The effect of treatments on the weight of thousands grains was not significant (Table 3).The effect of green manure and interactions of tested treatments on grain yield at 5% probability level and the effect of phosphorus and nitrogen fertilizers on this trait at 1%probability level was significant (Table 3). Mesgarbashi *et al*. observed that the interaction of nitrogen and returning residues on the weight of thousands wheat grain was not significant.

Planting *Vigna radiata* green manure on 10thAugust and 3rd July increased the grain yield compared to fallow percent treatment (Table 3). Delayed planting green manure reduced the beneficial effects of it on the seed yield. Early planting of *Vigna radiata* on 3rd July increased the wet and dry bio-mass when returning to soil. Rose et al., (2001) concluded that environmental factors such as soil temperature and the volume of green manure bio-mass are very important in the amounts of organic matters and nitrogen provided by these fertilizers. [13] Increased grain yield in this treatment was due to the increase in the number of spikes per unit and the number of grains per spike. Singh et al (1992) reported, planting legumes as green manure increases the yield of wheat seed through increasing the amount of available nutrients and organic matter. [14]. Increased amount of phosphorus had no significant effect on the average yield of grain. Khazaei et al., (2008) reported that by increasing phosphorus up to 10 mg per kg of soil, the yield of wheat seed had no significant change. [15] According to Miller et al., (2002),the kind of plants cultivated in previous years can improve the performance of next plant by creating different conditions in soil (nitrogen, organic matter, water availability). [16].

Table (3): Mean comparison of grain yield and its related traits in the studied treatments

Crop year	Means 2009-2012							
Treatments	Grain per spike	Grain per spikelet	Gran per m2	Spike per m2	Spikelet per spike	1000-grain weight (g)	Grain yield (g/m2)	Biological yield (g/m2)
Fallow	19.6b	1.5b	7808b	390b	11.3a	39a	399b	763b
3-Jul	21.9a	2.0a	9837a	443a	11.3a	39a	497a	905a
10-Aug	21.4ab	1.7ab	9155a	412b	12.0a	38a	426b	815ab
N_0	18.7c	1.6b	6838c	365c	11.1b	38a	359b	752b
N_{60}	21.5b	1.7b	9046b	436b	12.4a	38a	458a	844b
N_{120}	23.6a	1.9a	10880a	473a	12.6a	39a	492a	1002a
P_0	20.1a	1.5a	8014b	381b	11.2a	37a	400a	806a
P_{45}	22.0a	1.7a	8980ab	430ab	11.9a	38a	439a	841a
P_{90}	22.3a	1.8a	9791a	455a	12.3a	39a	466a	859a

In each column, there is a significant difference between the means with dissimilar letters according to Duncan's multi range test at 5% level.

Results showed that the highest grain yield is dedicated to a combination of 120 kg N +90 kg phosphorus on planting green manure on 3rd July. By planting green manure, the amount of phosphorus fertilizer consumption has declined. Study of grain yield in the control plots without consumption of mineral fertilizers showed that planting Vigna radiate as green manure on 3 July increased the average of this trait over the fallow condition16.8 percent. Naidiu (1981) also concluded that supplying 75% of the wheat needthrough Urea fertilizer and 25% by green manure had the highest grain yield. [17]. Table 4.

Biological yield intreatments of green manure was significantly increased compared to the fallow treatment (Table 3). In a way that planting *Vigna radiata* as green manure on 3rd July and 10th August, increased the amount of biological function as 15.69 and 6.38% compared to the fallow condition, respectively. Examining the effect of treatment interaction showed that, in treatment 120 kg N + 90 kg phosphorus and planting *Vigna radiata* on 3rd July, increased 29.40% the biological function compound to this fertilizer in fallow condition. In the control plots without mineral fertilizers, planting *Vigna radiata* on 10thAugust had no effect on biological function, while on 3rd July, this trait increased as about 9.98%. (Table 4) Edalat et al., (2006) also reported that crop alternation had a significant effect on biological yield of wheat and wheat biological yield increased by using nitrogen fertilizer [18].

The highest and lowest number of spikes in unit area was dedicated to planting *Vigna radiata* 3rd July and fallow, respectively (Table 3). By using 120 kg nitrogen and 90 kg phosphorus per hectare, the number of spikes to control plot without fertilizer has increased. The results are consistent with the reports by Minard and Jofery (2001) on the increase in the number of spikes per unit area and increasing the nitrogen content. [19]

The effect of planting date of green manure and interaction of treatments on the number of spikelet's per spike at the probability level 5% and the effect of nitrogen on this trait at the probability level of 1% was significant. Effects of phosphorus fertilizer on the number of spikelets per spike were not significant. (Table 3 and 4) The results showed that increasing nitrogen and phosphorus will increase the number of spikelets per spike. Darwinkel [20] reported that an increase in nitrogen levels through increasing the photosynthetic level in wheat increases the supply of photosynthesis matters required for spike growth and the reaction increases the production of spikelet's per spike. Effect of planting date of green manure, nitrogen and the interaction of treatments on the number of grains per spikelets at the probability level of 1% was significant, while the effect of phosphorus on this trait is not significant.

Table (4): Mean comparison of the interactive effect of the studied treatments on the grain yield and its related traits

Treatments		Means 2009-2012						
		Grain per spikelet	**Grain per spike**	**Spikelet per spike**	**Spike per m^2**	**1000-grain weight (g)**	**Grain yield (g/m^2)**	**Biological yield (g/m^2)**
Fallow	N1P1	1.5abcdef	18efg	10c	290e	37a	375cdef	694de
	N1P2	1.5abcdef	19cdef	11bc	359cde	38a	377cdef	781cde
	N1P3	1.5abcdef	20def	11bc	384bcde	39a	376def	744de
	N2P1	1.5abcdef	19cdefg	12ab	390cde	38a	382cdef	795cde
	N2P2	1.6abcdef	19cdefg	12ab	411bcde	38a	428abcdef	789cde
	N2P3	1.5abcdef	22abcdef	11bc	417abcde	40a	441abcdef	756cde
	N3P1	1.6abcdef	20def	12ab	430abcd	39a	430abcdef	772cde
	N3P2	1.7abcde	22abcdef	13ab	439abcd	37a	435abcdef	786cde
	N3P3	2.0a	22abcdef	14a	433abcd	39a	438abcdef	811cde
3-Jul	N1P1	1.5bcdef	20def	12ab	322de	38a	358def	771cde
	N1P2	1.6Abcde	19cdefg	11bc	387cde	41a	413bcdef	801cde
	N1P3	1.7abcde	20def	12ab	476abc	39a	428bcdef	811cde
	N2P1	1.7abcde	22abcdef	12ab	450abcd	41a	432abcdef	804cde
	N2P2	1.8abcde	23abcde	12ab	415abcd	38a	499abcd	825bcde
	N2P3	1.8abcd	23abcde	14a	468abc	38a	523abcd	851bcde
	N3P1	1.8abcd	21bcdef	12ab	468abc	39a	531abc	1012abc
	N3P2	2.0a	24abcd	14a	529ab	38a	536ab	1081ab
	N3P3	2.0a	25a	14a	545a	42a	585a	1150a
10-Aug	N1P1	1.0F	16fg	9c	233de	37a	298f	684de
	N1P2	1.2Ef	15g	11bc	382cde	39a	314ef	657e
	N1P3	1.4def	19efg	12ab	406abcde	39a	411bcdef	764cde
	N2P1	1.5bcdef	21abcdef	12ab	410abcde	38a	429abcdef	807cde
	N2P2	1.5bcdef	22abcdef	10bc	459abc	38a	450abcde	808cde
	N2P3	1.5bcdef	21abcdef	12ab	448abcd	38a	460abcde	831bcde
	N3P1	1.8abcd	23abcde	10bc	454abcde	40a	445abcdef	920aced
	N3P2	1.9abc	25abcd	13ab	460abc	39a	470abcde	961abcd
	N3P3	2.3a	26a	12ab	469abc	39a	481abcd	963abcd

In each column, there is a significant difference between the means with dissimilar letters according to Duncan's multi range test at 5% level. N and P: nitrogen and phosphorus treatments respectively.

The maximum number of grains per spike was obtained on 3rdJuly(Table 3). Planting green manure on 3rdJuly and 10th August increased the number of grains per spike compared to fallow treatment. It seems that increasing the number of seeds in spike in 120 kg nitrogen per hectare was done due to the increased number of spikelets per spike and number of grains per spikelets. The results were compatible with reports by Madhaj *et al* [21].

Although, the effect of phosphorus fertilizer on seed was not significant, but consuming 90 kg phosphorus per hectare has increased the number of spikelets by 9.86%. The maximum number of grains per spike is dedicated to the combined treatment of 120 kg N +90 kg phosphorus on 3rd July. The lowest number of grains per spike was dedicated to low levels of inorganic fertilizer under fallow condition. The highest number of grains in spikelets was dedicated to combined treatment 120 kg N +90 kg phosphorus on planting green manure on 3rd July (Table 3). Fisher [2] stated that the number of grains per spike increased by increasing the use of nitrogen. [22].

Increased nitrogen levels were significantly increased grain number per spikelets. Peltonen and Peltonen [23] concluded that reduced nitrogen content, the number of fertilized florets per spikelet's has significantly decreased. In these studies, reducing the number of grains per spikelet's was done due to an increase in the number of sterile florets. The date of planting green manure on 3rd July and fallow treatment dedicated the highest and lowest mean seed number per spikelet's (Table 3).

The highest number of seeds per unit area was obtained on 3rd July (Table 3). Increased nitrogen fertilizer significantly increased grain number per unit area. It seems that increasing the number of seeds in spikelets in 120 kg nitrogen per hectare treatment was due to the increased number of spike number

traits and the number of grains per spike. The maximum number of grain per hectare in combinational treatment of 120 kg N +90 kg phosphorus was dedicated to planting green manure on 3rd July. The number of grains per spike is one of the important components per unit area. Positive significant correlation of grain yield and number of grains per spike has been reported in several studies [21].

Economic importance

The first and best food identified for man is bread and its products that are produced from wheat. Wheat is known as the most essential agricultural product around the world and people all over the world use it daily as much as they need. Therefore, everyone knows the importance of wheat and all the experts agree that it is the most strategic crop [24].

Therefore, targeting to achieve the minimum cost has two optimal points, including achieving maximum physical output and achieving maximum gross income.

So today in agriculture, obtaining the maximum profit according to the available and accessible facilities is of utmost importance. One of the decisive factors in achieving maximum economic profit is planning for how to select the type and composition of crops in the region, taking into account all climatic, geographical, social, political and economic factors.

Recalling the fact that the agricultural sector, as one of the most important sectors of the economy, not only has a duty to feed people but also play a role in the development process in different ways, so the optimum use of production factors in this sector is very important for increasing the production of agricultural products. Therefore, with respect to the technical points of production, and adopting policies to increase production efficiency in this sector, economical production of these products is of high importance.

Due to constraints of agricultural sector, it seems that the most appropriate way to achieve growth rates necessary to produce wheat is improving performance and increasing efficiency of those who use wheat by increasing production through developing production factors and major changes in available technologies. Therefore, regarding the improvement of the efficiency at micro and macro-economic level (national) is of considerable importance.

In this study, we examined the method of calculating a purely economic interest. In this regard, the explanation is given below, the formula for calculating the economic benefit is as follows.

$$NR - (Y \cdot P) - (II + W)$$

In this equation, NR or Net return is economic interest. P or the Price is the amount of money received for the sale of a product unit (kg per hectare or tone per hectare) and H or the costs, include all the costs of planting, growing and harvesting. All the costs of planting *Vigna radiata* was considered in using *Vigna radiata* as pre-planting. And what is important is comparing the use of green manure, especially in treatment which had the highest performance with the fallow [25]. In fact, we calculated and compared NR for the treatment of two planting date of green manure and fallow. The cost, performance and profits are shown in the table. (Table 5, 6)

Table (5): Evaluation of economic efficiency with the use of green manures and organic

Switch	Average product(t/ha)	Surplus yield (t/ha)	The value of surplus yield($)	The cost of fertilizer, add it to the soil and green manure ($)	Cost of harvesting, transportation, classified according to species and maintaining ($)	Other costs ($)	Total cost ($)	Excess profit ($)	% Marginal benefit
Fallow	2.9	-	-	-	-	-	-	-	-
3-Jul	3.8	0.9	324	42.0	54	7.70	103.7	220.3	67.9
10-Aug	3.5	0.7	252	42.0	46	7.04	95.4	156.6	62.1
N_0	2.6								
N_{60}	3.4	0.8	288	66.0	50	8.80	124.8	163.0	56.6
N_{120}	4.2	1.6	576	132.0	75	16.60	223.6	352.4	61.2
P_0	3.0								
P_{45}	3.2	0.2	72.0	50.0	32	6.70	89.3	-17.3	-
P_{90}	3.8	0.8	288	102.0	54	12.5	168.5	119.5	41.5

Note: The price is $ 36 hundred kilograms of grain.

Table (6): ns between green manure phosphorus and nitrogen fertilizers in economic productivity's

Fallow	N1P1	3.00	-	-	-	-	-	-	-	-
	N3P3	4.38	1.38	496.8	182.4	135	29.4	346.8	150.0	30.2
3-Jul	N1P1	3.58	-	-	-	-	-	-	-	-
	N3P3	5.85	2.27	817.2	178.0	135	25.04	338.0	479.2	58.6
10-Aug	N1P1	2.98	-	-	-	-	-	-	-	-
	N3P3	4.8	1.82	655.2	182.4	135	29.4	346.8	308.4	47.1

Note: The price is $ 36 hundred kilograms of grain

Results in Tables 5 and 6 shows that the highest economic interest is on 3rd July and planting on 3 July and 10 August increased economic benefit of wheat compared to fallow. The wheat economic profit is shown on 3 July as 67.9% and in the 10 August 62.1%. Increasing nitrogen to 120 kg results in 61.2% increase as compared to without nitrogen fertilizer and increase in phosphorus fertilizer to 90 kg showed a 41.5% increase compared to the fallow.

In Table 6 that shows the interaction between planting date of green manure, nitrogen and phosphorus, the best economic benefit to fallow was planting date of 3 July, with 120 kg of nitrogen fertilizer and phosphate fertilizer with 90 kg.

Overall, results indicated that the sowing *Vigna radiata* for use as green manure increased the yield of wheat seed compared with fallow conditions. It was also found that when using *Vigna radiata* as green manure, seed yield in 60 kg nitrogen treatment and 45 kg phosphorus fertilizers per hectare, was more than 120 kg N +90 kg P ha in fallow condition. Increasing the grain yield in green manure treatments compared to fallow treatment was due to the increased number of grain per unit area and biological yield. It seems that the use of green and mineral fertilizers at the same time increases the absorption of mineral fertilizers as well as using wheat of nutrients in green fertilizers.

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