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The effect of returning *Eruca Sativa* and *Vicia villosa* residues at different nitrogen levels on soil chemical characteristics and purslane production in the semi-arid region of Birjand, Iran

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Abstract

To investigate the effect of return of Eruca residues and hairy vetch at different levels of nitrogen on the yield of purslane seeds, an experiment was conducted in two crop years 2013-2014 and 2014-2015 in the research farm of Birjand University. The experiment was carried using split plots based on a randomized complete block design with three replications. The factors included four levels of return of plant residues (Eruca, hairy vetch, mixture of Eruca and hairy vetch and control) as the main factor and three levels of pure nitrogen (zero, 50, and 100 kg ha^{-1}) as secondary factors. The traits studied in this experiment included: organic carbon and soil nitrogen percentage, soil absorbable phosphorus, soil pH and EC, and biomass nitrogen percentage. The results showed that the use of plant residues increased the percentage of organic carbon, soil nitrogen, and absorbable phosphorus and decreased soil pH. Among the treatments of the plant residues studied, the cluster flower vetch was superior to the others. Also, the use of nitrogen fertilizer increased the amount of absorbable phosphorus, soil electrical conductivity, and grain yield and decreased soil pH. According to the results of this experiment, to reduce the consumption of chemical fertilizers and support sustainable agriculture, the combination of Eruca and marigold without nitrogen fertilizer is recommended for maximizing nitrogen absorption in purslane biomass. To achieve the maximum seed yield of marigold, applying 100 kg of nitrogen per hectare in the Birjand area is advised.

Let me know if you need further adjustments!

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Introduction

Considering the population growth, especially in recent years, food security has become one of the most important challenges of every country. One of the ways to increase the production of crops is the use of fertilizer sources, which in recent years has led to the use of chemical fertilizers. Although the use of chemical fertilizers is the fastest way to ensure soil fertility, the destruction of soil structure, increase in production costs, and environmental pollution are worrisome; therefore, reducing chemical fertilizers and replacing them with natural and in-field inputs is inevitable (Den Hollander et al., 2007).

Using leguminous plants as green manure in rotation with crops can be one of the ways to reduce chemical fertilizers, especially nitrogen fertilizers. Legumes are widely used as green manure plants in agricultural systems due to their ability to fix air nitrogen and also provide conditions for the activity of beneficial soil microorganisms (Hooker et al., 2008). In a research, the use of green manure increased the percentage of organic matter, percentage of nitrogen and percentage of phosphorus in the soil (Adekiya et al., 2017). In another study, the use of a mixture of vetiver (*Vicia panunica* L.) with barley (*Hordeum vulgare* L.) as a green manure compared to the control (no plant planting) increased the yield of chickpea (*Cicer arietinum* L.) (Ghalavand et al., 2009).

Nitrogen is the most important element of soil fertility and forms the main part of chemical fertilizer consumption. Nitrogen is not efficiently absorbed by plants due to leaching and sublimation. Research has shown that the use of organic fertilizers through the activity of microorganisms, while helping to absorb more nutrients and increasing plant performance, reduces adverse environmental effects such as stabilization and excessive accumulation of elements in the soil and contamination of underground water (Rahimzadeh et al., 2013). In a research, the application of 250 kg of nitrogen per hectare compared to the control (without fertilizer use) increased the yield of purslane seeds (Inanloofar et al., 2013).

Purslane (*Portulaca oleracea* L.) is an annual four-carbon plant from the Portulacaceae family that is resistant to environmental stresses such as salinity and drought and is used for various purposes such as human nutrition, processing and pharmaceutical industries (Kafi and Rahimi et al., 2010; Rahimi et al., 2011). Cultivation of medicinal plants based on sustainable agriculture guarantees their quality and reduces the possibility of negative effects of the use of chemical inputs on the medicinal quality of these plants (Rahimzadeh et al., 2013).

Iran has a dry and semi-arid climate, and its soils often lack organic matter (less than one percent), and the calcareous nature of these soils prevents the absorption of nutrients (Rahimzadeh et al., 2013). Therefore, replacing organic with chemical fertilizers or their integrated application, while gradually releasing nutrients according to the needs of the plant (Rezvani Moghaddam and Seyyedi, 2014) and increasing the efficiency of inputs through the development of plant roots, absorbing more water and nutrients, and improving the physical and chemical properties of soil (Ebrahimian et al., 2017) make the agricultural system sustainable in the long term.

Given the limited information on the nutritional management of medicinal plants, along with the need to enhance soil fertility and reduce chemical fertilizer use, this research aims to investigate the effects of Eruca plant residues and cluster flower vetch on soil chemistry and nitrogen absorption by purslane biomass in Birjand, Iran.

Materials and Methods

The experiments were conducted over two cropping years, 2013-2014 and 2014-2015, at the research farm of the Faculty of Agriculture at Birjand University, located at 32 degrees 52 minutes north latitude and 59 degrees 13 minutes east longitude, at an altitude of 1,480 meters above sea level. Based on the Ambergate classification system, the climatic conditions of the test site are categorized as dry.

The 30-year average rainfall of this area is 152.2 mm, the absolute maximum temperature is 42.6, the absolute minimum temperature is -21.5 and the average monthly temperature is 16.5 degrees Celsius. The results of the soil analysis of the test site in the two studied crop years are shown in Table 1.

Table 1. Results of soil analysis at 0-30 cm depth in the study years

Crop year	Soil texture	EC (dS. m^{-1})	pH	OM (%)	N (mg.kg^{-1})	P (mg.kg^{-1})	K (mg.kg^{-1})
2013-2014	Loam- clay	2.89	7.14	0.46	0.147	5.4	276
2015-2016	Loam	7.30	7.60	0.70	0.073	12.4	297

This experiment was carried out in the form of split plots based on the randomized complete block design with three replications. The studied factors included four levels of plant residues (Eruca, hairy vetch, mixture of Eruca, hairy vetch and control) as the main factor and three levels of pure nitrogen (0, 50 and 100 kg ha^{-1}) as secondary factors.

Land preparation was completed in early November. Planting of Eruca and cluster flower vetch was done in the first half of November. The amount of seed used for Eruca was 20 kg ha^{-1} (1000 seed weight 3 gr), 135 kg ha^{-1} (1000 seed weight 54 gr) and 10 and 67.5 kg for the mixture of Eruca plants and 67.5 kg respectively. After the completion of the vegetative period and before entering the reproductive period, the aerial parts of the Eruca and the cluster flower were returned to the ground with a tiller.

Purslane seeds with vertical growth type were used in the plantation that was conducted in the first half of May. Nitrogen fertilizer was applied based on soil decomposition. Based on the studied treatment, nitrogen fertilizer was supplied to the plant from the source of urea in two stages (one half before planting and the other in early spring, and one half after the first furrow). During the growing season, the plant was harvested twice. To determine the grain yield, after removing the side rows and in 0.5 meters at the beginning and end of each plot, harvesting was done during physiological ripening (yellowing of 70% of the capsules). After harvest, the plants were placed outside for several days, then the seeds were separated and collected and weighed, and the seed yield was calculated. To determine the percentage of nitrogen in purslane biomass, samples were randomly selected from each plot and taken at the physiological ripening stage (yellowing of 70% of the capsules). Then the samples were dried in an oven at 80°C for 72 hours and powdered by a mill. To determine nitrogen percentage of the plant tissue, first the ground samples were digested using sulfuric acid and a catalyst, and then the amount of nitrogen in the resulting extract was measured by the Kjeldahl method (Bremner and Mulvaney, 1965).

Soil sampling was done from 0 to 30 cm depth and from three places in each plot and mixed together. The soil samples were placed outside and then passed through a 2 mm sieve. The amount of soil organic carbon was measured by Walkley and Black's method through soil organic carbon oxide in the vicinity of potassium dichromate and concentrated acid and then titration with ferrous ammonium sulfate solution was implemented (Walkly and Black, 1934). Total nitrogen was measured using the Kjeldahl method (Bremner and Mulvaney, 1965) and absorbable phosphorus was measured using the Olsen method (Olsen et al., 1954). Soil acidity was determined on saturated soil using a pH meter and electrical conductivity was determined on saturated soil extract using an EC meter.

After data collection, combined analysis was performed using Minitab 17 software. To compare the means, the LSD test was used at the five percent probability level.

Results and discussion

Percentage of soil organic carbon and nitrogen

The results of composite variance analysis showed that the effect of plant residues and the interaction effect of plant residues and nitrogen on the percentage of organic carbon and soil nitrogen were significant at the 1% probability level, but the effect of nitrogen and other interactions between these factors were not significant (Table 2). The results of the mean comparison showed that the use of plant residues compared to the control (no fertilizer use) increased the percentage of organic carbon and soil nitrogen. The highest organic carbon (0.9 %) and soil nitrogen (0.086 %) were obtained from vetiver treatment. The Eruca and the mixture of Eruca and vetiver were included in the same group (Table 3). Some studies indicated the positive effect of plant residue application on soil organic carbon and nitrogen (Dabighi et al., 2016; Adekiya et al., 2017). In a research, the use of Eruca plant residues due to high biomass and nitrogen fixation due to symbiotic method increased soil organic matter (Poorhaskanhi Dowlatabad et al., 2015). The results of a study indicated an increase in soil nitrogen due to the application of Iranian clover and clover (Jahan et al., 2014). Legumes are widely used as green manure in agricultural systems due to their ability to fix air nitrogen and provide conditions for the activity of beneficial soil microorganisms (Hooker et al., 2008).

The results of comparing the average effect of plant residues and nitrogen on the percentage of soil organic carbon and nitrogen showed that in the control (no fertilizer use), the percentage of soil organic carbon and nitrogen decreased with the increase of nitrogen up to 50 kg ha^{-1}. In the Eruca treatment, the increase in nitrogen decreased the percentage of soil organic carbon and nitrogen. This was while the percentage of soil organic carbon and nitrogen increased with the increase of nitrogen in the treatment of the cluster flower vetch. In the mixed treatment of Eruca and sedum, the increase of nitrogen up to 50 kg ha^{-1} increased the percentage of soil organic carbon and nitrogen (Table 4). Research results indicated that soil organic carbon increased with the increase of nitrogen and in the residue retention treatment compared to the residue harvesting treatment (Mirzashahi et al., 2016). The role of soil microbial biomass in changing soil organic matter is confirmed.

So that the circulation and mineralization of organic precursors is often caused by soil microbial biomass (Rathke et al., 2005). The studies of some researchers indicate the irregular behavior of the microbial biomass carbon due to the use of chemical fertilizers (Yevdokimov et al., 2008). So that the application of fertilizers in conditions of nutrient limitation has a stimulating effect on soil microbial growth (Hoyle et al., 2006) and on the other hand, large amounts of nitrogen fertilizers lead to osmotic stress and cell death of sensitive microorganisms, and the ability to use carbon sources from materials Organic matter (cellulose and lignin) increases in soil due to inactivation of ligninase enzyme (Yevdokimov et al., 2008).

The amount of phosphorus that can be absorbed by the soil

The results of combined analysis of variance showed that the effect of plant residues, nitrogen and the interaction effect of plant residues and nitrogen was significant on the amount of absorbable phosphorus in the soil at the probability level of 1%, but other interaction effects on this trait were not significant (Table 2). The results of the mean comparison showed that regarding the effect of plant residues on the amount of absorbable phosphorus in the soil the use of plant residues increased the absorbable phosphorus of the soil. So that the use of treatments of hairy vetch ,Eruca mixture,-and hairy vetch and Eruca resulted in an increase of 60.53, 24.52 and 15.7 percent absorbable phosphorus in the soil compared to the control (Table 3). The results of the study of several researchers indicate an increase in soil phosphorus due to the use of green manure (Silva Carvalho, 2015; Mirzashahi et al., 2016; Adekiya et al., 2017; Trupiano et al., 2017). In a research, the positive effect of leguminous plants as green manure in increasing the amount of phosphorus in the soil has been mentioned (Dabighi et al., 2016). With the increase of nitrogen levels, the amount of absorbable phosphorus increased in the soil (Table 5). The results of some researchs indicate the positive effect of nitrogen consumption on the amount of absorbable phosphorus in the soil (Mirzashahi et al., 2016; Adekiya et al., 2017). It seems that the increase of nitrogen through the decrease of soil pH (Table 5) has increased the solubility of phosphorus and its increase in the soil.

Table 2. Combined analysis of variance (mean squares) effect of plant remains and nitrogen on soil chemical properties, biomass N adsorption and grain yield of Purslane

Sources of variance	d.f	Soil organic carbon percentage	Nitrogen percentage of soil	Phosphorus absorbable in the soil	pH	EC	Percentage of nitrogen biomass	Grain yield
Year (Y)	1	0.06 *	0.0002 *	119.6 **	10.12 **	12.73 **	0.17 **	2173186**
Replication (Y)	4	0.00003	0.00001	26.49	0.008	0.37	0.009	47538
Plant remains (A)	3	0.14 **	0.0006 **	32.41 **	0.74 **	0.02 n.s	0.11 **	78041 n.s
Y×A	3	0.007 n.s	0.00003 n.s	1.30 n.s	0.69 **	0.002 n.s	0.09 **	83010 n.s
E_a	12	0.015	0.00006	1.33	0.006	0.07	0.006	148203
Nitrogen (B)	2	0.014 n.s	0.00006 n.s	6.05 **	0.007 **	0.14 **	0.029 n.s	203927**
Y×B	2	0.00003 n.s	0.000001 n.s	0.25 n.s	0.00001 n.s	0.005 n.s	0.003 n.s	16241 n.s
A×B	6	0.092 **	0.0004 **	6.71 **	0.004 **	0.17 **	0.13 **	111751 *
Y×A×B	6	0.00005 n.s	0.00001 n.s	0.25 n.s	0.00001 n.s	0.007 n.s	0.004 n.s	41618 n.s
E_b	32	0.0095	0.00004	0.74	0.0003	0.01	0.012	35231
CV (%)		12.22	8.24	13.19	0.22	6.19	10.01	13.24

**,* and ns are significant at 1 and 5% probability levels and non-significant, respectively

Table 3. Comparison of the effect of plant remains on some chemical properties of soil and N uptake by Purslane

Plant remains	Soil organic carbon (%)	Soil Nitrogen (%)	phosphorus absorbable in soil ($mg.kg^{-1}$)	pH	Biomass Nitrogen (%)
Control	0.69 c	0.072 c	5.22 c	7.95 a	1.11 bc
Eruca sativa	0.78 b	0.078 b	6.04 b	7.54 b	1.13 b
Vicia villosa	0.90 a	0.086 a	8.38 a	7.55 b	1.04 c
Eruca sativa + *Vicia villosa*	0.81 b	0.080 b	6.50 b	7.53 c	1.24 a
LSD 5%	0.08	0.005	0.83	0.056	0.056

Means with the same letter in each column are not significantly different based on LSD test ($p \leq 0.05$).

Table 4. Comparison of interaction between plant remains and nitrogen on soil chemical properties, N adsorption and grain yield of Purslane

Plant remains	Nitrogen fertilizer levels (kg. ha^{-1})	Soil organic carbon (%)	Soil Nitrogen (%)	phosphorus absorbable in soil (mg.kg^{-1})	pH	EC (dS. m^{-1})	Biomass Nitrogen (%)	Grain yield (kg. ha^{-1})
Control	0	0.80 cd	0.079 cd	4.23 e	7.95 a	1.84 e	0.95 d	1256.68 c
	50	0.47 e	0.057 e	5.96 d	7.95 a	2.16 abc	1.08 cd	1361.37 bc
	100	0.79 cd	0.079 cd	5.46 d	7.95 a	2.22 abc	1.30 a	1350.94 bc
Eruca sativa	0	0.81 bcd	0.080 bcd	6.43 cd	7.59 b	1.91 e	1.23 ab	1345.67 bc
	50	0.77 d	0.078 d	5.73 d	7.52 d	2.30 a	1.03 cd	1456.43 bc
	100	0.74 d	0.075 d	5.96 d	7.52 d	2.12 bc	1.14 bc	1505.35 b
Vicia villosa	0	0.85 bcd	0.083 bcd	7.21 bc	7.55 c	2.25 ab	0.99 d	1322.83 bc
	50	0.90 abc	0.086 abc	7.48 b	7.55 c	2.08 cd	0.99 d	1309.87 bc
	100	0.96 a	0.090 a	10.46 a	7.55 c	2.15 abc	1.16 bc	1798.94 a
Eruca sativa + Vicia villosa	0	0.76 d	0.077 d	7.00 bc	7.55 c	2.13 bc	1.36 a	1382.98 bc
	50	0.92 ab	0.088 ab	6.25 cd	7.55 c	1.93 de	1.29 a	1433.44 bc
	100	0.76 d	0.077 d	6.25 cd	7.48 e	2.25 ab	1.08 cd	1476.05 bc
LSD 5%		0.11	0.007	1.01	0.02	0.11	0.12	220.7

Means with the same letter in each column are not significantly different based on LSD test ($p \leq 0.05$).

Table 5. Comparison of the effect of nitrogen fertilizer on some soil chemical properties after Purslane Harvest

Nitrogen fertilizer levels (kg. ha^{-1})	phosphorus absorbable in soil (mg.kg^{-1})	pH	EC (dS. m^{-1})
0	6.03 b	7.66 a	2.03 b
50	6.54 a	7.64 b	2.12 a
100	7.03 a	7.63 c	2.18 a
LSD 5%	0.5	0.008	0.07

Means with the same letter in each column are not significantly different based on LSD test ($p \leq 0.05$).

The comparison of mean mutual effects revealed that increasing nitrogen levels in the control treatment and hairy vetch enhanced the amount of absorbable phosphorus in the soil. In contrast, higher nitrogen levels in the Eruca treatments and the mixture of Eruca decreased absorbable phosphorus (Table 4). Notably, the application of hairy vetch with 100 kg ha^{-1} of nitrogen resulted in a 2.47-fold increase in absorbable phosphorus compared to the control (no fertilizer use) (Table 4). Previous research has shown that returning plant residues along with nitrogen application increases the soil's available phosphorus (Mirzashahi et al., 2016).

Soil pH

The results of combined analysis of variance showed that the effect of plant residues, the interaction effect of year and plant residues, the effect of nitrogen and the interaction between plant residues and nitrogen on soil pH were significant at the probability level of 1%, but other interaction effects on these traits were not significant (Table 2). The results of the mean comparison indicated a decrease in soil pH due to the return of plant residues. So, among the studied plant residues, the mixture of Eruca and mashka has the lowest soil pH (Table 3). The results of some studies indicate a decrease in soil pH due to the use of plant residues (Ebrahimian et al., 2017). Generally, the production of carbon dioxide during the decomposition process of organic materials (Ebrahimian et al., 2017), the decomposition of organic compounds and the production of organic acids such as citric acid and oxalic acid during the decomposition process of plant residues (Ebrahimian et al., 2017) are among the factors. Which may lead to a local decrease in soil pH. Soil pH decreased with increasing nitrogen levels (Table 5). Research results showed that the use of chemical fertilizers causes soil acidification (Ngo et al., 2012). Adding a large amount of fertilizers that add hydrogen ions to the soil directly or after a series of reactions (such as urea compounds) causes a decrease in soil pH and acidification (Ngo et al., 2012).

The results of interaction mean comparison effect of plant residues and nitrogen showed that the increase of nitrogen levels in the Eruca treatments and the mixture of Eruca and the hairy vetch caused a decrease in soil pH. Among the studied treatments, the mixture of Eruca and sedum and 100 kg of nitrogen per hectare had the lowest soil pH (7.48) (Table 4). In this study, the two-year average biomass of Eruca, sedum, and mixture of Eruca and sedum was 6.27, 1.1, and 7.66 t ha^{-1}, respectively. Therefore, the high volume of residues returned to the soil and the stimulation of microbial activities at high levels of nitrogen resulted in the lowest pH of the soil obtained from the mixed treatment of Eruca and clustered vetiver, followed by the treatment of Eruca.

Electrical conductivity of the soil

The results of combined analysis of variance showed that the effect of nitrogen and the interaction between plant residues and nitrogen on soil electrical conductivity were significant at the probability level of 1%. However, the effect of plant residues and other interactions on this trait was not significant (Table 2). Increasing nitrogen levels increased soil electrical conductivity (Table 9). The obtained result was consistent with the results of Sharma et al. (Sharma et al., 2011). It seems that chemical fertilizers have increased the electrical conductivity of the soil by increasing solutes in the soil.

The comparison of interaction means between plant residues and nitrogen levels indicated that increasing nitrogen levels in the control treatment (no fertilizer use) and the return treatments of plant residues elevated the electrical conductivity of the soil. Conversely, the use of plant residues did not reduce or regulate the electrical conductivity. In this context, research on cover crops has shown that cultivating cover crops has no significant effect on soil electrical conductivity (Jahan et al., 2014).

Biomass nitrogen percentage

The results of combined analysis of variance showed that the effect of green manure, the interaction between year and green manure, and the interaction between green manure and nitrogen on the nitrogen percentage of purslane biomass were significant at the 1% probability level. But the effect of nitrogen and other interactions were not significant (Table 2). The result of interaction means comparison showed that the highest biomass nitrogen was obtained from the mixed treatment of Eruca (1.24 %), followed by Eruca (1.13 %), and the lowest from Eruca (1.04 %). Table 3). Environmental factors such as rainfall, temperature, length of growth period and soil fertility and management decisions such as tillage operations and time to return the cover crops to the soil can affect the amount of nitrogen accumulated in the cover crop and its availability for the next plant (Dabighi et al. al., 2016). The results of a study showed that some Poaceae and Brassicaceae species perform well in trapping nitrogen in autumn and winter (Shamsaddin Saied et al., 2017). Also, in another research, non-leguminous cover crops are mentioned as nitrogen-receiving plants to absorb residual nitrogen in the soil to prevent nitrate leaching (Dabighi et al., 2016). Poorhaskanhi Dowlatabad et al., (2015) showed Eruca is the best green manure due to the high biomass production and the accumulation of a large amount of nitrogen in its leaves (Poorhaskanhi Dowlatabad et al., 2015). In this study, the mixed treatment of Eruca and sedum rose due to its higher biomass than other treatments and the higher share of Eruca (Brassica family and non-legumes) in this mixture caused an increase in purslane biomass nitrogen. Due to the delay in returning it to the soil, the treatment of mallow did not have enough time to release nitrogen and it had the lowest percentage of biomass nitrogen in purslane.

The result of interaction means comparison of plant residues and nitrogen showed that the increase of nitrogen levels in the control treatments (no fertilizer use) and the caused an increase in nitrogen of purslane biomass. This was despite of the fact that in the treatments of Eruca and the mixture of Eruca and, the increase in nitrogen caused a decrease in purslane biomass nitrogen (Table 4). The highest amount of nitrogen in the aerial parts of rapeseed was obtained from mung bean (legume) green manure treatment in combination with 50% chemical fertilizer and nitroxine (Dabighi et al., 2016). Also, in this research, with the increase of nitrogen, the percentage of nitrogen in rapeseed aerial organs increased (Dabighi et al., 2016). It seems that in the control, the increase in nitrogen levels increased the ability of the plant to access nitrogen. Also, the delay in returning the cluster flower vetch (due to later flowering compared to Eruca) has delayed the decomposition of residues and the release of nitrogen at the same time as the plant needs. Therefore, the use of mineral nitrogen in high amounts, as in the control treatment, has increased the plant's access to nitrogen and increased the percentage of biomass nitrogen at high levels of nitrogen. In the treatments of Eruca and Eruca mixture and clustered vetiver, the release of nutrients, especially nitrogen, was carried out simultaneously with the plant's needs during the purslane growing season, and the further increase of nitrogen may have reduced the availability and absorption of nitrogen and other nutrients through soil poisoning.

Grain Yield

The results of combined analysis of variance showed that the effect of nitrogen and the interaction means comparison of plant residues and nitrogen on grain yield were significant at the probability level of one percent and five percent, respectively, but the effect of plant residues and other double and triple effects on these traits were not significant (Table 2). The result of interaction means comparison between plant residues and nitrogen on grain yield showed that in the control treatment (no fertilizer use), increasing in nitrogen up to 50 kg ha^{-1} increased grain yield by 7.69%. With the increase of nitrogen fertilizer from 50 to 100 kg ha^{-1}, no change in grain yield was observed. In the Eruca treatment and flower-cluster vetch, increasing nitrogen from 0 to 100 kg ha^{-1} in treatments of Eruca and flower-cluster vetch increased the grain yield by 10.6 and 26.46%, respectively. The increase of nitrogen did not affect the grain yield in the mixed treatment of Eruca and flower cluster vetch (Table 4). In other words, when only nitrogen fertilizer was used, the highest seed yield was obtained from 50 kg ha^{-1} of nitrogen, but when the combination of residues (Eruca and marigold) and nitrogen was used, the increase of nitrogen up to 100 kg ha^{-1} increased seed yield It seems that when plant residues are used, nitrogen consumption up to 50 kg ha^{-1} is spent on the competition of microorganisms in nitrogen absorption and the further increase of nitrogen fertilizer along with the gradual release of nutrients (especially nitrogen) by plant residues is the reason for the increase in grain yield in these treatments. according to the results, the highest yield of purslane seeds was obtained from the treatment of Eruca (1798.94 kg ha^{-1}), which is due to the improvement of some chemical properties of the soil, such as the percentage of organic carbon, the percentage of nitrogen and phosphorus that can be absorbed by the soil (Table 4). In a several-year research, the use of plants as green manure (especially the legume family) along with the use of nitrogen chemical fertilizer increased the absorption efficiency of this element and increased yield (shah et al., 2011).

Conclusion

In general, the two-year results of this experiment indicated the effective role of returning plant residues (especially sedge) on the soil chemical properties and the yield of purslane seeds. Also, the role of nitrogen on the soil chemical properties was limited to increasing the percentage of absorbable phosphorus in the soil. In most cases, the effect of combining plant residues and nitrogen on soil chemical properties was very small. However, the maximum grain yield was obtained from the integrated treatment of mullein and 100 kg ha^{-1} of nitrogen. Due to the low soil organic matter in most arid and semi-arid regions of Iran, especially in South Khorasan, it seems that with proper management in the use of organic resources, it is possible to improve the soils condition in these regions and provide the conditions for the growth and performance of medicinal plants such as purslane.

According to the results of this experiment, to reduce the consumption of chemical fertilizers and support sustainable agriculture, the combination of Eruca and marigold without nitrogen fertilizer is recommended for maximizing nitrogen absorption in purslane biomass. To achieve the maximum seed yield of marigold, applying 100 kg of nitrogen per hectare in the Birjand area is advised.

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