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Effect of NPK Levels on Seed Yield and Oil Contents of Rapeseed (Brassica napus L.) Under Sulaimani Condition-Iraq Kurdistan Region

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ABSTRACT

This experiment was conducted during the winter season of 2016-2017 at the Qlyasan Agricultural Research Station, College of Agricultural Engineering Sciences, University of Sulaimani, using split plot design the main plots conducted in (RCBD) with three replicates to study the effect of three levels of NPK fertilizer on the growth, yield and yield component of rapeseed varieties. The three varieties; Serw, Hybrid and Readny were implemented in the sub plots, three NPK fertilizer levels (0, 150 and 300) kg NPK ha-1 from NPK fertilizer complex (15-15-15), were implemented in the main plot. Results of this investigation confirm that variety Readny produced the best values for most characters, and application of 300Kg NPK ha-1 was found to be the best level for this crop. The character seed yield showed positive and highly significant correlation with most characters including plant height, number of leaves per plant, number of pods per plant, the weight of pod per plant, 1000-seed weight, dry matter weight per plant, LA, and biological yield. Maximum positive direct effect on seed yield recorded by weight of pod per plant which was 0.495, while Maximum positive indirect effect on seed yield was 0.483 recorded by weight of pod per plant via number of pods per plant.

INTRODUCTION

Brassica napus L. classifies to the Brassicaceae family and has become one of the important oilseed crops in the agricultural systems of semi-arid regions where water deficit and high temperatures restrict growth and yield during the reproductive growth in Iraq. Oilseed rape is one of the most widely cultivated oil crops in the world. The world production of rapeseed was about 68.86 million tons in 2016 and, as edible vegetable oil only soybean and palm oil production exceeded that of oilseed rape (FAOSTAT, 2016). It contains (40 - 45%) oil and (39%) protein (Eskandari and Kazemi, 2012). It is cultivated for its oil, which can be used as an edible product or for various industrial applications ((Malagoli et al., 2005a; Malagoli et al., 2005b). Rapeseed oil is ordinarily utilized in human diets on account of its great nutritional quality with a high proportion of unsaturated fatty acids and fair-minded fatty-acid composition (Rehman et al., 2013; Wang et al., 2014). After extraction, remaining rapeseed meal can be used as an organic fertilizer to the cropland or as a source of animal feed (Gao et al., 2010). The nutritional nature of these products is of prime significance, because of their immediate and circuitous effects on human health. Additionally, rapeseed oil is developing consideration as an imperative option for bioenergy asset, because of the deficiency and unpredictability of the worldwide petroleum supply (Högy et al. 2010). Modern varieties of rapeseed are capable of giving higher yields when grown under optimum fertility level. There are many factors affecting growth, development yield and quality of the rapeseed crop such as, varieties which is an important genetic factor. It contributes a lot for growth, yield and yield

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components of a particular crop. Yield components are directly related to the genotype and the neighboring environments (Rahman et al., 2004). Rapeseed varieties are quite high yielding under appropriate environmental condition.

The use of mineral fertilizer plays an important role in achieving high seed yields (Ren et al. 2013). Macronutrient Nitrogen (N), phosphorous (P), and potassium (K) are critical elements for crop plant growth and development, and applying fertilizers, especially N to crops, is a valuable agronomic practice (Zhao et al., 2013). However, excessive fertilization can result in nutrient inefficiencies and excessive losses of N and P in the field environment, and also impact soil, water and air quality, human health, and biodiversity (Goulding et al., 2008). For winter rapeseed, K and P are important nutrients. Nutritional requirements of rapeseed for these macro elements are much higher than for cereal crops, but only a small part of them is removed with seeds (Brennan et al., 2009). Despite the high soil abundance of P and K, plants may be malnourished (Gaj, R., 2011). Potassium is taken up by rapeseed in the largest amounts (Szczepaniak, 2014). Insufficient availability of K strongly limits the growth and yield of rapeseed (Giovahi, M. and Saffari, M., 2006). According to Szczepaniak, (2014), the number of seeds in pods, as a prerequisite of the final yield, depends on the K management pattern in rapeseed canopy before and after the flowering stage

However, the information on yield dynamics of Rapeseed with respect to fertilizers is still lacking in Iraqi Kurdistan region. Therefore, the present study was conducted to determine the effect of three levels of NPK on growth, seed yield and oil content of Rapeseed under rain feed conditions of Sulaimani.

MATERIALS AND METHODS

This investigation was carried out in Sulaimani city, to study the effect of varieties and different NPK fertilizer levels on yield and yield components of rape seed in the experimental Farm at the Qlyasan Agricultural Research Station, College of Agricultural Sciences, University of Sulaimani (Latitude 35° 34′ 307″ ; N, Longitude 45° 21′ 992″ ; E, 765 MASL), located 2 km North West of Sulaimani city during the winter seasons of 2016-2017.The meteorological data of Bakrajo location is shown in Table (1).

Table (1) Average air temperature and rainfall during the growing seasons of 2016-2017 at Qlyasan Location

Months	Average Air Temperature (°C)		Rainfall (mm)
	Max.	*Min.*	
November	21.3	7.6	44.5
December	11.1	3.0	158.0
January	11.10	1.46	59.2
February	13.02	0.26	96.5
March	17.73	7.45	111.5
April	23.89	10.97	54.5
May	31.63	13.48	27.7
Total			551.9

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The experimental area plots were ploughed twice, harrowed and well leveled. Some physical and chemical properties of the experimental soil is given in Table (2). Three rape seed varieties were selected for cultivation, which has been provided by The Baghdad Agricultural Research Center, namely; Serw, Hybrid and Reandy. The experiment was arranged as split- plot layout. Different levels of NPK fertilizer (0, 150 and 300 Kg NPK ha^{-1}) from NPK fertilizer complex (15-15-15) were implemented in the main plots and conducted with Randomized Complete Block Design (RCBD), The varieties were implemented in the subplots. Each main plot was consisted of three subplots with four rows each, four meters long and 0.25 meter apart. Seeds were cultivated at a rate of 12 Kg ha^{-1}. The cultural operations and weed control were accomplished according to normal field practices. The LSD test was conducted to find the significant differences between treatment means at 1 % and 5% probability level. Mature plants were harvested on July 20, of 2017 to estimate seed yield, yield components and growth rate.

Table (2) Some physical and chemical properties of soil analysis at experimental site

Soil Properties		
Physical properties		
Soil Properties		Qlyasan Location
Textural Class		Silty Clay Loam
Particle Size Distribution ($g\ kg^{-1}$)	Sand	59.68
	Silt	619.17
	Clay	312.15
Chemical properties		
Soil Properties		Qlyasan Location
PH		7.42
EC dS m^{-1} At 25 °C		0.38
Organic Matter ($g\ kg^{-1}$)		19.59
Total Nitrogen ($g\ kg^{-1}$)		1.07
Available Phosphate (mg kg-1)		9.61
$CaCO_3$ (mg kg-1)		215.68
Soluble Ions mmol L^{-1}	Calcium (Ca^{+2})	2.00
	Potassium (K^{+})	0.16
	Sodium (Na^{+})	0.46
	Mg^{2+}	0.81
	HCO_3^{-}	2.51
	$SO4^{2-}$	0.79

Studied Characteristics

The studied characters were

-At 50% flowering

Dry matter (gplant-1): The mean weight of five plant sample were dried in oven for 48 hours in 65 C o then weighted and recorded.

LA: The mean of leaves area (mm2) of the five plant samples was measured by Leaf Area Meter (AREA METER AM100, ADC BIOSCIENTIFIC LTD) and converted to (cm2) then recorded.

At Maturity

Plant height (cm): The mean height of the plant from ground level to the tip of five plants were recorded.

No. of leaves per plant: The mean number of leaves per plant of the five plants was recorded.

No. of pods per plant: The mean number of pods per plant of the five plants was recorded.

Weight of pods per plant (g): The mean of pods weight of the five plant samples was recorded.

Pod Length (cm): The mean length of pods of the five plants was recorded.

Number of seeds per pod: The mean number of seeds per pods of five plants was counted and recorded.

1000 seed weight (g): 100 seeds were weighted then multiplied by (10) and recorded as 1000-seed weight.

Harvest Index: Measured by divided Seed yield (t ha-1) to Biological yield (t ha-1) according to the following equation:

Biological yield (ton ha-1): The weight of a square meter without the roots was recorded in each plot (g m-2) and converted to (ton ha-1).

Seed yield (ton ha-1): weight of the seed square meter of plants was recorded in each plot (g m-2) and converted to (ton ha-1).

The Oil Percentage (%): (NIR) Near Infrared Reflectance used for extraction of oil in the seed.

The Protein Percentage (%):(NIR) Near Infrared Reflectance used for extraction of protein in the seed.

Correlation Analysis

The correlation coefficient was conducted to determine the degree of association of characters with seed yield and also among all the criteria studied. Phenotypic correlations were computed between the characters in the growing season using the formula given by Singh and Chaudhary (1985).

Path Coefficient Analysis

The path coefficient analysis was carried out as suggested by Dewey and Lu (1959). Seed yield was kept as resultant variable and other characters as causal through (Analysis of Moment Structures) AMOS Ver. 18 Software.

RESULTS AND DISCUSSION

The impact of NPK fertilizer application was found to be highly significant for all characters (Table 3)The application of 300 Kg/ha recorded the best values for all characters except oil percentage and harvest index recording 111.667cm, 30.748, 76.831, 8.252g, 6.204cm, 25.259, 3.900g, 3.472g, 216.509, 16.897%, 13.091t/ha and 5.338 t/ ha for the characters plant high, number of leaves per plant, number of pod per plant, weight of pod per plant, pod length, number of seed per pod, 1000 seed weight, dry matter weight, LA ,protein percentage, biological yield and seed yield respectively, while the control treatment recorded the maximum value for the character oil percentage and harvest index with 33.5825% and 0.507 but gave the lowest values for the other characters with 77.333cm, 16.007, 39.073, 4.510g, 5.689, 19.598 3.354g, 2.052g, 99.524cm2, 14.869, 5.663t/ha and 2.854t/ha for plant high, number of leaves per plant, number of pod per plant, weight of pod per plant, pod length, number of seed per pod, 1000 seed weight, dry matter weight, LA, protein percentage, biological yield and seed yield respectively. This supports Nielsen's finding (1997) that higher rates of N fertilizer levels also increased the pod number in Canola. Other researchers reported a significant effect of chemical fertilizer on plant height on canola plants (Sharifi, 2012; Seyed et al., 2011).

Enhancement in plant height with the increased use of chemical fertilizer can be related to increases the length of plant cells on main stem (Nasiri et al., 2004). These results agree with that of Cheema et al. (2001) who reported that seed yield increased in response to increasing N rates up to a certain limit. Since plant height represents a characteristic of genetic and environment combinations, the combined effect of various NPK treatments on plants height has been significant. It refers to a crop's vegetative growth potential. Plant height was unaffected by phosphorus or potassium. Although the method of applying nitrogen had a major impact on plant height. Increased P levels resulted in a linear increase in seed yield (Jain et al., 1995). Increased P levels also increased N and K uptake and consumption, as well as dry matter output (Jain et al., 1995). Phosphorus (P) is an essential nutrient for crop growth and production, second only to nitrogen, in terms of photosynthesis, cellular energy transfer, respiration, nucleic acid biosynthesis, and as a part of many plant structures such as phospholipids (Vance et al., 2003). Even though canola needs more phosphorus than grain crops for optimal yields, it can need only small amounts of P fertilizers, as it is exceptionally well-suited to using both applied and soil P (Irshad et al., 2016). In addition to nitrogen and phosphorus fertilization, potassium fertilization has been considered to influence seed yield production and oil concentrations (Singh et al., 1997). According to some researchers (Al-Hasanie and Al-Maadhedi 2017; Mohammed et al., 2020), increased NPK levels are to account for increased seed yield.

Data in Table (4) confirm that the differences among varieties were highly significant for all studied characters except harvest index. It was observed that the variety Reandy were recorded maximum values for all studied characters except oil percentage with 101.000 cm, 30.258, 72.360, 7.833 g 6.198 cm, 24.473, 4.017 g, 3.506 g ,182.373cm2,17.640%, 31.289%,11.522 t/ha and 4.906 t/ha for the character's plant high, number of leaves per plant, number of pods per plant, weight of pod per plant, pod length, number of seeds per pod, 1000 seed weight, dry matter weight, LA, protein percentage, oil percentage, biological yield and seed yield respectively. The variety Serw produced minimum values for all of the characters excepted number of seeds per pod, LA and oil percentage, recording 86.333 cm, 19.563, 37.923, 4.147 g, 5.733 cm, 3.372 g, 2.149 g, 14.096 % ,6. 870 t/ha and 2.948 t/ha for the character's plant high, number of leaves per plant, number of pod per plant, weight of pod per plant, pod length cm, 1000 seed weight, dry matter weight, protein percentage, biological yield and seed yield respectively. Different varieties of rapeseed affect the quality and quantity of rapeseed growth, yield and oil percentage formation production, which was typically characteristic of a species, the genetic variations among the varieties under the study may lead to the variation in their responses to the use of different levels of NPK fertilizer. This finding was closely related to Banna, (2011), Ryan et al. (2009) and Mohammed et al., (2020) who stated that there were significant differences among rapeseed genotypes in their seed weight and other characters Furthermore, (El-Nakhlawy and Bakhashwain, 2009) explained that genotypes had significant effect on protein content, the highest value (30.24%) was obtained from Pactol genotype, while the lowest value (23.13%) was obtained from Callypso genotype. (Miri and Bagheri, 2013) stated that canola yield and yield components were greatly affected by different cultivars.

Data in Table (5) confirm that the interaction between varieties and NPK application levels was highly significant for the character plant high, number of leaves per plant, weight of pod per plant, number of seeds per pod, dry matter weight and biological yield and were significant for the character's number of pod per plant, protein percentage and seed yield. The interaction between Reandy and 300 Kg/ha of NPK fertilizer recorded maximum value for all character with 120.333 cm, 37.550, 101.107, 11.413 g, 28.033,4.403 g, 19.030%, 15.501 t/ha and 6.540 t/ha for the character plant high, number of leaves per plant, number of pod per plant, weight of pod per plant, number of seeds per pod, dry matter weight, protein percentage, biological yield and seed yield respectively, while the interaction between Serw and the control treatment recorded the lowest value except number of seeds per pod with 66.667 cm, 13.257, 28.610, 3.110 g, 1.380 g, 13.493%, 4.149 t/ha and 2.233 t/ha for the character plant high, number of leaves per plant, number of pod per plant, weight of pod per plant, dry matter weight, protein percentage, biological yield and seed yield respectively. Fertilizers treatments and the varieties effected significantly on growth characters (Al-Hasanie and Al-Maadhedi, 2017). Burhan and AL-Hassan (2019) stated that the Interaction between cultivars and NPK fertilizer treatments greatly affected significantly on the number of pod plant-1, 1000 seed weight, biological yield and seed yield.

Data in Table (6) shows the simple correlation coefficient among all studied characters. highly significant and positive correlation was recorded between all double characters with exception of oil percent and harvest index. The oil percentage recorded highly significant and negative correlation with all characters except number of seeds of per pod, which was only significant and negative, and LA which was not significant. While the harvest index recorded highly significant and negative correlation with all characters except number of pods per plant, weight of pod per plant, number of seeds per pod, which were only significant and negative, and with oil percentage was significant and positive. LA gave significant and positive correlation with number of pods per plant. Significant correlation between seed yield and most its components calculated for same crops by (Abdulkhaleq and Tawfiq. 2014; Abdulkhaleq et al., 2018; Hama, 2019; Tofiq et al., 2020).

Data in Table (7) illustrate the path coefficient analysis between seed yield and other characters. Maximum positive direct effect on seed yield recorded by weight of pod per plant which was 0.495 and followed by number of seeds per pod 0.265. Maximum negative direct effect on seed yield was -0.394 recorded by harvest index. Maximum positive indirect effect on seed yield was

0.483 recorded by weight of pod per plant via number of pods per plant and followed by 0.450 for also weight of pod per plant via dry mater. It was indicated previously that the character dry matter, number of leaves per plant, 1000 seed weight, biological yield, weight of pods per plant, number of seeds per pod, number of pods per plant, average pod weight, LA, pod length recorded high positive indirect effect on seed yield via the character plant height with 0.847, 0.844, 0.819, 0.798, 0.777, 0.775, 0.772, 0.713, 0.706, 0.659 respectively, while the character harvest index and oil percentage recorded high negative indirect effect also via plant height with -0.623 and -0.505 respectively (Abdulkhaleq et al., 2018) . Rameeh (2011) found similar results, which are also in partial agreement with Dar et al. (2010), Tahira et al. (2012), and Hama (2019).

Table (3) NPK-fertilizer levels effect on the studied characters

NPK Fertilizer Kg ha-1	Plant height cm	No. of leaves plant-1	No. of pods plant-1	Weight of pods g plant-1	Pod length cm	No. of seeds pod-1	1000 Seed weight g	Dry matter g plant-1	LA cm^2 plant-1	Protein %	Oil %	HI	Biol. yield ton ha^{-1}	Seed yield ton ha^{-1}
0	77.333	16.007	39.073	4.510	5.689	19.598	3.354	2.052	99.524	14.869	33.582	0.507	5.663	2.854
150	89.222	26.282	49.936	5.523	5.998	22.457	3.739	2.856	194.733	16.122	32.838	0.422	9.604	3.769
300	111.667	30.748	76.831	8.252	6.204	25.259	3.900	3.472	216.509	16.897	32.113	0.410	13.091	5.338
L.S.D ($P \leq 0.05$)	2.255	1.641	8.531	0.855	0.232	0.711	0.274	0.088	12.355	0.445	0.493	0.059	0.486	0.360
L.S.D ($P \leq 0.01$)	3.107	2.261	11.753	1.177	0.319	0.979	0.378	0.122	17.022	0.613	0.679	0.082	0.670	0.496

Table (4) The averages of Rapeseed varieties for the studied characters

Varieties	Plant height cm	No. of leaves plant-1	No. of pods plant-1	weight of pods g plant-1	Pod length cm	No. of seeds pod-1	1000 Seed weight g	Dry matter g plant-1	LA cm^2 plant-1	Protein %	Oil %	HI	Biol. yield ton ha^{-1}	Seed yield ton ha^{-1}
Serw	86.333	19.563	37.923	4.147	5.733	21.926	3.372	2.149	165.818	14.096	34.413	0.477	6.870	2.948
Hybrid	90.889	23.216	55.557	6.305	5.960	20.914	3.604	2.726	162.576	16.152	32.831	0.426	9.966	4.107
Reandy	101.000	30.258	72.360	7.833	6.198	24.473	4.017	3.506	182.373	17.640	31.289	0.437	11.522	4.906
L.S.D *($P\leq0.05$)*	2.255	1.641	8.531	0.855	0.232	0.711	0.274	3.506	12.355	0.445	0.493	0.000	0.486	0.360
L.S.D *($P\leq0.01$)*	3.107	2.261	11.753	1.177	0.319	0.979	0.378	0.122	17.022	0.613	0.679	N.s	0.670	0.496

Table (5) The interactions between the rapeseed varieties and the NPK fertilizer level in the characteristics studied

NPK-fertilizer ×Varieties	Plant height cm	No. of leaves plant-1	No. of pods plant-1	Weight of pods g plant-1	Pod length cm)	No. of seeds pod-1	1000 Seed weight g	Dry matter g plant-1	LA cm^2 plant-1	Protein %	Oil %	HI	Biol. yield ton ha^{-1}	Seed yield ton ha^{-1}
0 × Serw	66.667	13.257	28.610	3.110	5.490	20.933	2.963	1.380	82.820	13.493	35.297	0.537	4.149	2.233
150 × Serw	78.000	15.717	39.507	4.693	5.620	17.960	3.333	2.267	99.840	15.180	33.423	0.483	6.024	2.925
300 × Serw	87.333	19.047	49.103	5.727	5.957	19.900	3.767	2.510	115.913	15.933	32.027	0.500	6.815	3.403
0 × Hybrid	90.000	20.283	38.383	4.367	5.800	21.277	3.537	2.233	201.543	14.240	34.383	0.480	6.960	2.688
150 × Hybrid	82.333	24.387	44.553	5.842	6.027	20.607	3.613	2.730	177.580	16.170	32.767	0.400	9.603	3.842
300 × Hybrid	95.333	34.177	66.870	6.360	6.167	25.487	4.067	3.603	205.077	17.957	31.363	0.387	12.250	4.776
0 × Reandy	102.333	25.150	46.777	4.963	5.910	23.567	3.617	2.833	213.090	14.553	33.560	0.413	9.501	3.921
150 × Reandy	112.333	29.543	82.610	8.380	6.233	24.177	3.867	3.180	210.307	17.107	32.303	0.393	14.271	5.554
300 × Reandy	120.333	37.550	101.107	11.413	6.470	28.033	4.217	4.403	226.130	19.030	30.477	0.423	15.501	6.540
L.S.D $_{(P\leq0.05)}$	3.906	2.842	14.775	1.480	n.s	1.231	n.s	0.153	n.s	0.771	n.s	n.s	0.842	0.624
L.S.D $_{(P\leq0.01)}$	5.382	3.916	n.s	2.039	n.s	1.696	n.s	0.211	n.s	n.s	n.s	n.s	1.160	n.s

Table (6) Correlation analysis between the studied characters with seed yield

Characters	Plant height cm	No. of leaves plant-1	No. of pods plant-1	Weight of pods g plant-1	Pod length cm	No. of seeds pod-1	1000 Seed weight g	Dry matter g plant-1	LA cm² plant-1	Protein %	Oil %	HI	Biol. yield ton ha^{-1}	Seed yield ton ha^{-1}
Plant height cm	1													
No. of leaves plant-1	0.859**	1												
No. of pods plant-1	0.899**	0.894**	1											
Weight of pods g plant-1	0.865**	0.848**	0.974**	1										
Pod length cm	0.884**	0.944**	0.929**	0.925**	1									
No. of seeds pod-1	0.823**	0.910**	0.839**	0.766**	0.811**	1								
1000 Seed weight (g)	0.848**	0.921**	0.869**	0.845**	0.955**	0.755**	1							
Dry matter g plant-1	0.873**	0.964**	0.920**	0.909**	0.950**	0.833**	0.951**	1						
LA cm²plant-1	0.841**	0.843**	0.659*	0.617**	0.780**	0.776**	0.754**	0.763**	1					
Protein %	0.722**	0.889**	0.911**	0.903**	0.918**	0.716**	0.909**	0.932**	0.557*	1				
Oil %	-0.712**	-0.833**	-0.852**	-0.859**	-0.899**	-0.632*	-0.934**	-0.917**	-0.511N.s	-0.963**	1			
HI	-0.674**	-0.821**	-0.616*	-0.568*	-0.757**	-0.611*	-0.718**	-0.754**	-0.817**	-0.664**	0.617*	1		
Biol. yield ton ha^{-1}	0.909**	0.959**	0.946**	0.908**	0.954**	0.858**	0.881**	0.935**	0.818**	0.881**	-0.809**	-0.830**	1	
Seed yield ton ha^{-1}	0.904**	0.935**	0.979**	0.957**	0.954**	0.851**	0.880**	0.947**	0.721**	0.913**	-0.861**	-0.740**	0.981**	1

Table (7) Path coefficient analysis between the studied seed yield characters

Characters	*Plant height cm*	No. of leaves plant-1	No. of pods plant-1	Weight of pods g plant-1	*Pod length cm*	No. of seeds pod-1	1000 Seed weight g	Dry matter g plant-1	LA cm² plant-1	Protein %	Oil %	HI	Biol. yield ton ha^{-1}	Seed yield ton ha^{-1}
Plant height cm	0.242978	0	0.080	0.428	0	0.218	0.032	-0.090	-0.273	0	0	0.265	0	0.904**
No. of leaves plant-1	0.209	0	0.080	0.420	0	0.241	0.035	-0.099	-0.274	0	0	0.323	0	0.935**
No. of pods plant-1	0.218	0	0.089	0.483	0	0.223	0.033	-0.094	-0.214	0	0	0.242	0	0.979**
Weight of pods g plant-1	0.210	0	0.087	0.495	0	0.203	0.032	-0.093	-0.200	0	0	0.224	0	0.957**
Pod length cm	0.215	0	0.083	0.458	0	0.215	0.036	-0.097	-0.253	0	0	0.298	0	0.954**
No. of seeds pod-1	0.200	0	0.075	0.379	0	0.265	0.029	-0.085	-0.252	0	0	0.240	0	0.851**
1000 Seed weight g	0.206	0	0.077	0.418	0	0.200	0.038	-0.098	-0.245	0	0	0.282	0	0.880**
Dry matter g plant-1	0.212	0	0.082	0.450	0	0.221	0.036	-0.103	-0.248	0	0	0.297	0	0.947**
LA cm² plant-1	0.204	0	0.059	0.305	0	0.206	0.029	-0.078	-0.325	0	0	0.321	0	0.721**
Protein %	0.175	0	0.081	0.447	0	0.190	0.035	-0.096	-0.181	0	0	0.261	0	0.913**
Oil %	-0.173	0	-0.076	-0.426	0	-0.168	-0.036	0.094	0.166	0	0	-0.243	0	-0.861**
HI	-0.164	0	-0.055	-0.281	0	-0.162	-0.027	0.077	0.265	0	0	-0.394	0	-0.740**
Biol. yield ton ha^{-1}	0.221	0	0.084	0.449	0	0.228	0.034	-0.096	-0.266	0	0	0.327	0	0.981**
Seed yield ton ha^{-1}														

CONCLUSION

It was observed that the variety Reandy recorded maximum values for almost all of the studied characters. The application of 300 Kg ha-1 recorded the best values for almost all of the studied characters, while the control treatment recorded the maximum value for the character oil percentage only. Plant height was the character with a maximum potential of selection for seed yield improvement and also can be used for increasing the oil content because this character possessed highly significant positive correlation and maximum positive direct effects with seed yield. Almost all of the characters had a high positive indirect effect via this character.

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تاثير مستويات من العناصر الكبرى على حاصل البذور ومحتويات الزيت للسلجم (*Brassica napus L.*)

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الخلاصة

أجريت هذه التجربة خلال فصل الشتاء 2016-2017 في محطة قليسان للبحوث الزراعية ، كلية علوم الهندسة الزراعية ، جامعة السليمانية ، باستخدام تصميم القطع المنشقة، بتطبيق (RCBD) للالواح الرئيسية بثلاث مكررات لدراسة تأثير ثلاثة مستويات من سماد NPK على نمو وحاصل ومكونات حاصل السلجم لثلاثة أصناف وهى؛ Serw, Hybrid و Reandy حيث مثلت الالواح الفرعية ، اما مستويات سماد المركب كانت (0 ، 150 و 300) كجم / NPKهكتار من السماد المركب NPK (15-15-15)حيث مثلت الالواح لرئيسية. تؤكد نتائج هذا البحث أن صنف Reandy أنتج أفضل القيم لمعظم الصفات ، وان تطبيق 300 كغم \ NPKهكتار وجد ليكون أفضل مستوى لهذا المحصول. أظهر صفة حاصل البذور ارتباط موجب وعالي المعنوية مع معظم الصفات مثل طول النبات ، عدد الأوراق لكل نبات ، عدد القرون للنبات ، وزن القرون للنبات ، وزن 1000 بذرة ، وزن المادة الجافة للنبات ، المساحة الورقية و الحاصل البيولوجي. ان التأثير الإيجابي المباشر الأعلى في حاصل البذور سجلت لوزن القرنة للنبات وهو 0.495 بينما كان أقصى تأثير إيجابي غير مباشر في حاصل البذور 0.483 لوزن القرون للنبات من خلال عدد القرون للنبات.

الكلمات المفتاحية: أصناف بذور اللفت ، سماد مركب ، الحاصل ، نسبة الزيت، معامل الارتباط وتحليل المسار.