Response of some Rapeseed Cultivars (*Brassica napus* L.) to Plant Populations under Mosul City Conditions

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Abstract:

The study included two field experiments for rapeseed crop *(Brassica napus* L.*)* conducted during two winter successive seasons 2008-2009, 2009-2010 at AL-Rashidia location which is far about (22 km) west north Mosul city. Each experiment was conducted according to factorial experiment in randomized completely block design with three replications. Its included three plant population (55555, 83333 and 166666 plants. hectar^{-1}) with three cultivars of rapeseed crop (Kara, Rafal and Bristol).

The results could be summarized as:

The plant population of 55555 plants. hectar^{-1} gave the highest mean for characters stem diameter, number of primary branches, number of silique /plant, leaf area, number of seed per silique, weight of thousand seed, and oil, protein percentage in 2008-2009, 2009-2010 seasons, While the plant population of 166666 plants. hectar^{-1} gave a high mean for plant height in both growing seasons.

The cultivars differed significantly in all the related characteristics, the Rafal cultivar come over the other cultivars in plant height, stem diameter, number of branches/plant, leaf area, number of silique /plant, number of seed/ silique, 1000 seeds weight (g.) seed yield (ton.ha^{-1}), oil, protein percentage of seeds and oil, protein yield (ton.ha^{-1})in both growing seasons. The interaction between plant population and cultivars was significant in plant height in 2008-2009 season only, the Rafal cultivar with plant population at 166666 plants.hectar^{-1} gave highest plant height.

استجابة بعض أصناف السلجم (*Brassica napus* L.) للكثافات النباتية تحت ظروف منطقة الموصل

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ملخص البحث:

تضمنت الدراسة تجربتين حقليتين لمحصول السلجم (*Brassica napus L.*) نفذتا أثناء الموسم الشتوي للعامين المتعاقبين 2008 -2009 و2009 -2010 في موقع الرشيدية الذي يبعد حوالي (22كم) شمال غرب مدينة الموصل.

نفذت كل من التجربتين وفق نظام التجارب العاملية بتصميم القطاعات العشوائية الكاملة بثلاثة مكررات. تضمنت كل تجربة ثلاثة كثافات نباتية (55555، 83333 و166666 نبات/هكتار) وثلاثة أصناف من محصول السلجم (كارا، رفل وبريستول).

وتم التوصل إلى النتائج الآتية:

أعطت الكثافة النباتية الأولى (55555 نبات/هكتار) أعلى معدل لصفات قطر الساق، عدد الأفرع/نبات، عدد الخردلات/نبات، المساحة الورقية، عدد البذور/خردله، وزن الألف بذرة/غم، ونسبة الزيت والبروتين للموسمين 2008 -2009 و2009 -2010، في حين أعطت الكثافة النباتية الثالثة (166666 نبات/هكتار) أعلى معدل لصفة ارتفاع النبات في كلا موسمي الزراعة.

اختلفت الأصناف معنوياً في الصفات المدروسة جميعها، إذ تفوق ألصنف رفل في صفات: ارتفاع النبات/سم، قطر الساق، عدد الأفرع/نبات، المساحة الورقية، عدد الخردلات/نبات، عدد البذور/خردله، وزن الألف بذرة/غم، حاصل البذور الكلي والزيت والبروتين (طن/هكتار) ونسبتي الزيت والبروتين في كلا موسمي الزراعة. كان التداخل بين الكثافة النباتية والأصناف معنوياً لصفة ارتفاع النبات في موسم الزراعة 2008 -2009 فقط، أعطى الصنف رفل عند زراعته بكثافة نباتية 166666 نبات/هكتار أعلى قيمة لارتفاع النبات.

Introduction:

In general, Iraq has a suitable climate for many oilseeds crops. This is not completely true in Mosul with low temperatures and short growing season, where the oilseed crops usually perform poorly except sunflower and rapeseed. Rapeseed (*Brassica napus* L.) is a new and promising oilseed crop for this region, its seed high oil content ranging from 45-60 percent (AL-Doori and Hasan, 2010). In oilseed rape, plant population varies considerably worldwide, depending on the environment, production system and cultivar (Ozer, 2003). Previous studies have shown that plant population is an important factor affecting rapeseed yield. Plant population in rapeseed

governs the components of yield, and thus the yield of individual plants. A uniform distribution of plants per area unit is a prerequisite for yield stability (Diepenbrock 2000 and Ozer, 2003). Under Mosul city conditions, AL-Doori and Hasan (2010) investigated the effects of different row spacing (30 - 60 cm) in rapeseed, they concluded that number of silique per plant, seed weights and dry matter per plant, weight of thousand seed and oil yield increases as row spacing increased. Leach *et al*. (1999), also reported that plants grown at high population had fewer siliques bearing branches per plant but produced more branches, and that with an increase in population, weight of thousand seed increased. The same researchers also observed that there was no effect of population on seed oil content. Rapeseed has generally slight or inconsistent seed yield responses to various row spacing. Therefore, optimum densities for each crop and each environment should be determined by local research. The present study was undertaken to assess the effect of plant population on growth, yield and quality of three rapeseed cultivars *(Brassica napus* L.*).*

Materials and Methods:

Two filed experiments were carried out during two winter successive seasons 2008-2009, 2009-2010 at AL-Rashidia location which is far about (22km) to investigate the effect of three levels of plant population (55555, 83333 and 166666 plants.hectar^{-1}) on the growth, yield and quality of three rapeseed cultivars (Kara, Rafal and Bristol). AL-Rashidia is located in the west north region of Mosul city at Nineveh province. Climatically, the region placed in the semiarid temperature zone cold winter and hot summer. Average rainfall is about 375 mm that most rainfall concentrated between winter and spring. Each experiment included twenty seven experimental units comprising the combinations of three plant populations and three rapeseed cultivars with three replications.

Seeds of these cultivars were obtained from the industrial crops company, Baghdad. Each plot 18 m^2 (5*3.6), included six rows 60 cm apart and five meters long and the distance between hills were 30, 20 and 10 cm apart to attain a plant population of 55555, 83333 and 166666 plants per hectar^{-1} ,respectively. Super phosphate 60 kg.ha^{-1} (45%P_2O_5) and 40 kg.ha^{-1} potassium (48%K_2O) were applied to the soil during the sowing period, nitrogen fertilizers was applied in the form of urea 100 kg.ha^{-1} (46%N) in two equal doses, immediately after thinning (two weeks from sowing) and 20 days later.

The experimental design was factorial experiment in a Randomized Completely Block Design with three replications according to Snedecor and Cochran, 1982. Then Duncan's multiple range test (Duncan, 1955) was used to compare among means (SAS, 2001). A representative soil sample (0-30 cm depth) was taken before planting, (table 5) to determine some physical,

chemical and nutritional properties using the methods description by Black, 1965, Jackson, 1973, Page *et al*., 1982 and Tandon, 1999.

Sowing dates were on the third and fourteenth of October for 2008-2009, 2009-2010 seasons, respectively. After two weeks from sowing seedlings were thinned to one plant per hill according to populations needed. The plots were weeded twice, the first one after two weeks from sowing and the second after four weeks from sowing. The external two rows were left as border. Two of the remaining rows were devoted for estimating plant growth and some characteristics. Normal cultural practices of growing rapeseed were conducted in the usual manner followed by the farmers of the district.

The studied characters were:

Sample of ten plants except guarded plants each was taken from each treatment, then the following data were record: plant height (cm): The height of the main stem from ground level to the tip of the plant, stem diameter (cm): measured by using a vernier (caliper) at the third node, number of branches/plant: was determined by counting the number of primary reproductive branches and leaf area (cm^2.plant).

At harvest, (when the color of seed coat presented in the lower zone of the terminal raceme was darkish at 144, 141, 148 and 145, 143, 140 days after sowing for each cultivars Kara, Rafal and Bristol to both seasons 2008-2009, 2009-2010, respectively), ten plants except guarded plants were taken randomly from the two inner rows of each experimental plot, then the following data were measured; number of siliques per plant. Meanwhile, ten siliques were picked at random from these ten plants, and then the following characters were determined: Number of seeds per silique. The ten selected plants, mentioned above, were cut, put in an envelope and dried naturally in the lab. Their seeds were added to their respective seeds of the ten siliques in the small bags and weighed. Then weight of thousand seed (g) was estimated by counting thousand seeds at random from each plot and weighed using a sensitive balance. Oil seed content was determined using Soxhlet method (A.O.A.C., 1980), and seed nitrogen concentration was measured by microkjeldahl method, then, protein percentage was calculated by multiplying the nitrogen percentage by the converting factor 6.25 (Agrawal *et al*., 1980).

Results and Discussion:

1- Effect of plant population:

In the two growing seasons, the attributes of rapeseed exhibited significant differences for the different plant population except seed yield, oil and protein yield in the two growing seasons. Data reported in table (1) indicate the effect of plant population on rapeseed attributes i.e. plant height,

stem diameter, number of primary branches, leaf area (cm^2.plant), number of silique per plant, weight of 1000 seed (g) and oil, protein percentage in two seasons.

The low plant population (55555 plants. $hectar^{-1}$) had a larger stem diameter (2.35, 2.65cm), higher number of primary branches (12.31, 13.22), number of silique per plant (190.81, 188.37), leaf area (2500.89, 2314.22cm^2.plant), weight of 1000 seed (1.74, 1.91g) and oil (39.96, 41.04), protein (20.30, 22.35) percentage than the high plant population (166666 plants. $hectar^{-1}$), these results are true in the two growing seasons, respectively (table 2). This is in line with Sovero, (1993); Starner *et al*., (1996); Raymer, (2002); Lessani and Mojtahedi, (2006) who attributed this result to the better soil moisture availability, decreased plant competition and increased light penetration through plant canopy at a lower plant population. These results may be attributed to the competition between plants and between the different parts of the individual plant under high planting population. In the present study, planting population exerts significant effect on plant height. The plant height was positively response with increasing plant population up to 166666 plants. $hectar^{-1}$, these results are true in the two growing seasons. Similar results were reported by Ali *et al*.,(1990); Misra and Rana, (1992); Chauhan *et al*., (1993); Roy *et al*., (1993); Siddiqui, (1999); Yousaf and Ahmad, (2002); Alam, (2004) reported that high plant population (low row spacing) had significant effect on plant height. In contrast, Kuchtova and Vasak, (2004) found that high plant population had no significant effect on plant height. Also Fathi *et al*., (2002) showed that high plant population had decreased number of silique per plant and weight of thousand seed. Increasing plant population up to 166666 plants. $hectar^{-1}$ decreased oil and protein percentage at the two growing seasons. Sharma, (1992) and Al-Doori and Hasan, (2010) found that high row spacing had increased oil percentage.

2- Effect of rapeseed cultivars:

The significant variations in some growth characters, yield components and some related traits were presented in table (1). Data in table (3) revealed that Rafal cultivar had taller (134.45, 141.12 cm) and thicker plant (2.42, 2.74 cm), higher number of primary branches per plant (11.95, 13.12) then those of Kara and Bristol in both seasons 2008-2009, 2009-2010, respectively. The differences among the three cultivars in the plant height may be attributed to the general varietals differences in the number of internodes per plant (Singh and Kumar, 1990; Ozer, 2003; Sana *et al*., 2003; Biabani *et al*., 2008; Kargarzadeh *et al*., 2008 and AL-Doori, 2011). Moreover, the differences in leaf area among the three cultivars may be attributed to the differences in leaves per plant. In this concern, Al-Doori and Al-Dulaimy, (2011) showed that taller cultivars had more leaves and leaf primordial than the others

rapeseed cultivars. This might explain the consistent differences among the tested cultivars in all growth characters that were measured in this study. It can also noted that the number of silique.plant^{-1}, number of seeds per silique (12.03, 12.94), weight of thousand seed (1.77, 1.92 gm), yield and oil, protein yield (ton. hectar^{-1}) of Rafal cultivar out weighed Kara and Bristol in a descending order at both seasons, respectively. The superiority of Rafal cultivar in the dry matter production may be attributed to having the tallest and thickest plants, and as well the highest area of photosynthetic leaves and this in turn increased the capacity of dry matter accumulation in the different plant parts. However, the differences in oil, protein percent of seeds may be attributed to genetic factors and their interaction with the prevailing environmental conditions. This increase in oil, protein yield (ton.ha^{-1}) from Rafal cultivar may be due to their high seed yield. hectar^{-1} (table 3) rather than differences in seed oil content. Similar conclusion were reported by Singh and Kumar, (1990); Ozer, (2003); Sana *et al*., (2003); Biabani *et al*., (2008); Kargarzadeh *et al*., (2008). In this report, AL-Doori and Al-Dulaimy, (2011) reported that Emma cultivar had highest plant height, number of primary branches per plant than the Topas and Monty cultivars. The superiority of Rafal cultivar in the most seed characters may be due to that Rafal cultivar had better vegetative growth and hence photosynthetic area which led to more carbohydrates which was translocated from the leaves and stem to the seeds (Mengel and Kirkby, 1982).

3- The interaction effect between plant population and rapeseed cultivars:

Mean values of interaction between plant population and cultivars are presented in table (4). The interaction between the studying factors showed significant effects on plant height in 2008 season only (table 1). Rafal cultivar reflected the greatest response to plant population at 166666 plants. hectar^{-1} for plant height, with this regard, Hassan and El-Hakeem, (1996) and AL-Doori, (2012) found that high plant population produced higher plant height. The interaction between the plant population and cultivars for the other investigated traits were not statistically significant in both seasons, therefore the data were not discus. The insignificant effect between plant population and cultivars on other characteristic showed that each of these two factors acted independently on these traits.

Table -1- Analysis of variance for some growth characters, yield and yield components and quality in 2008-2009 and 2009-2010 seasons.

S.O.V	D.f	M.S. for 2008-2009 season											
		Plant height (cm)	stem diameter (cm)	no. of primary branches. $plant^{-1}$	no. of silique. $Plant^{-1}$	leaf area (cm^2\plant)	number of $seeds.silique^{-1}$	weight of 1000 seed (g)	seed yield ($ton.ha^{-1}$)	oil (%)	oil yield ($ton.ha^{-1}$)	protein (%)	protein yield ($ton.ha^{-1}$)
Replications	٢	251.14814	0.3522	3.221392	879.1481	63611.259	4.67907778	0.4044444	0.4192481	9.1628	0.0845827	11.7724	0.0258499
P	٢	2007.75**	0.600**	9.5290**	2269.7**	1511822.5*	8.198677**	0.34241**	0.01623 n.s.	10.4**	0.00158 n.s.	13.76**	0.00091 n.s.
C	٢	594.072**	0.975**	5.6606**	1047.7**	182513.6**	4.193633**	0.36537**	0.22797**	43.8**	0.06561**	24.21**	0.02027**
P × C	٤	26.5016**	0.016 n.s.	0.6961 n.s.	89.723 n.s.	3845.65 n.s.	0.309061 n.s.	0.02268 n.s.	0.00636 n.s.	0.44 n.s.	0.00139 n.s.	0.401 n.s.	0.00041 n.s.
Error	16	4.231481	0.0170	0.537392	39.85648	1812.093	0.29195278	0.0152777	0.0376439	0.5551	0.0078099	0.67604	0.0019018
Total	26												
S.O.V	D.f	M.S. for 2009-2010 season											
Replications	٢	148.11111	0.5337	1.876577	374.1111	203283.11	3.02640370	0.1403370	1.5558990	26.437	0.3028580	10.1709	0.0857508
P	٢	1207.77**	0.822**	12.550**	1243.9**	581493.9**	8.795381**	0.35102**	0.05426 n.s.	26.3**	0.00114 n.s.	22.98**	0.00034 n.s.
C	٢	574.525**	1.167**	11.517**	1630.7**	180705.9**	6.552225**	0.39223**	0.28812**	48.9**	0.09206**	20.74**	0.02940**
P × C	٤	24.1512 n.s.	0.016 n.s.	0.7431 n.s.	51.991 n.s.	3431.8 n.s.	0.347603 n.s.	0.01234 n.s.	0.00283 n.s.	1.29 n.s.	0.00039 n.s.	0.566 n.s.	0.00008 n.s.
Error	16	32.277778	0.0284	0.462494	38.61111	18104.778	0.37013704	0.0132787	0.0247271	0.6846	0.0048437	0.29408	0.0014338
Total	26												

*, ** Significant at the 0.05 and 0.01 probability levels, respectively. and n.s. not Significant.

Table -2- Effect of plant population on some growth characters, yield, yield components and quality in both seasons.

seasons	plant population (plants.ha^{-1})	Plant height (cm)	stem diameter (cm)	no. of primary branches. Plant^{-1}	no. of silique. Plant^{-1}	leaf area (cm^2\plant)	Number of seeds. silique^{-1}	weight of 1000 seed (g)	seed yield (ton.ha^{-1})	oil (%)	oil yield (ton.ha^{-1})	protein (%)	protein yield (ton.ha^{-1})
2008-2009	55555	113.19c	2.35a	12.31a	190.81a	2500.89a	12.27a	1.74a	0.901	39.96a	0.365	20.30a	0.187
	83333	121.55b	2.05b	11.15b	170.94b	2366.54b	11.32b	1.57b	0.984	38.77b	0.387	19.07b	0.191
	166666	142.20a	1.84c	10.26c	159.42c	1733.43c	10.36c	1.35c	0.956	37.82c	0.363	17.83c	0.172
2009-2010	55555	122.19c	2.65a	13.22a	188.37a	2314.22a	13.05a	1.91a	1.100	41.04a	0.459	22.35a	0.250
	83333	130.00b	2.34b	11.94b	176.05b	2187.66a	12.02b	1.67b	1.148	39.27b	0.457	20.38b	0.238
	166666	144.98a	2.05c	10.87c	164.87c	1824.54b	11.07c	1.52c	1.252	37.62c	0.477	19.18c	0.244

* The mean values within column followed by the different letters are significant at 0.01 and 0.05 probability levels, respectively.

Table -3- Effect of rapeseed cultivars on some growth characters, yield, yield components and quality in both seasons.

seasons	cultivars	Plant height (cm)	stem diameter (cm)	no. of primary branches. Plant^{-1}	no. of silique. Plant^{-1}	leaf area (cm^2\plant)	Number of seeds. silique^{-1}	weight of 1000 seed (g)	seed yield (ton.ha^{-1})	oil (%)	oil yield (ton.ha^{-1})	protein (%)	protein yield (ton.ha^{-1})
2008-2009	Kara	124.05b	2.04b	11.39a	174.49b	2217.60b	11.25b	1.51b	0.875b	38.42b	0.337b	18.72b	0.165b
	Rafal	134.45a	2.42a	11.95a	184.12a	2333.24a	12.03a	1.77a	1.129a	41.24a	0.469a	20.86a	0.237a
	Bristol	118.44c	1.77c	10.39b	162.58c	2050.02c	10.67c	1.37c	0.836b	36.89c	0.309b	17.63c	0.148b
2009-2010	Kara	130.61b	2.28b	12.06b	173.15b	2103.16b	11.97b	1.67b	1.094b	38.37b	0.421b	20.12b	0.222b
	Rafal	141.12a	2.74a	13.12a	191.23a	2253.24a	12.94a	1.92a	1.370a	41.96a	0.580a	22.35a	0.309a
	Bristol	125.44b	2.02c	10.86c	164.91c	1970.02b	11.24c	1.51c	1.035c	37.59b	0.392c	19.44c	0.201c

* The mean values within column followed by the different letters are significant at 0.01 and 0.05 probability levels, respectively.

Table -4-Effect of interaction between cultivars and plant population on some growth characters, yield and yield components and quality in 2008-2009 and 2009-2010 seasons respectively.

plant population (plants.ha^{-1})	cultivars	Plant height (cm)	stem diameter (cm)	no. of primary branches. Plant^{-1}	no. of silique. Plant^{-1}	leaf area (cm^2\plant)	number of seeds.silique^{-1}	weight of 1000 seed (g)	seed yield (ton.ha^{-1})	oil (%)	oil yield (ton.ha^{-1})	protein (%)	protein yield (ton.ha^{-1})
2008-2009 season													
55555	Kara	112.26f	2.34	12.38	188.07	2536.00	12.27	1.75	0.851	39.34	0.336	20.22	0.175
	Rafal	123.30d	2.64	13.46	207.30	2604.00	13.19	1.98	1.055	42.34	0.451	21.80	0.233
	Bristol	104.00g	2.08	11.11	177.07	2362.67	11.36	1.49	0.796	38.22	0.307	18.89	0.152
83333	Kara	118.75e	1.97	11.63	174.96	2406.70	11.30	1.57	0.906	37.86	0.343	17.62	0.159
	Rafal	132.58c	2.38	11.73	180.21	2494.20	12.13	1.73	1.226	41.24	0.511	20.99	0.259
	Bristol	113.33f	1.79	10.11	157.66	2198.73	10.53	1.41	0.854	35.46	0.302	16.10	0.137
166666	Kara	141.15b	1.83	10.16	160.43	1710.10	10.18	1.20	0.869	38.06	0.331	18.32	0.159
	Rafal	147.47a	2.25	10.68	164.84	1901.53	10.78	1.61	1.107	40.14	0.445	19.78	0.219
	Bristol	138.00b	1.44	9.95	153.00	1588.65	10.13	1.23	0.858	37.00	0.318	17.91	0.155
2009-2010 season													
55555	Kara	121.60	2.61	13.45	183.07	2312.7	12.87	1.86	1.058	40.19	0.430	21.88	0.234
	Rafal	131.97	2.98	14.59	208.30	2434.0	14.12	2.21	1.308	42.98	0.569	23.80	0.315
	Bristol	113.00	2.38	11.64	173.74	2196.0	12.16	1.67	0.935	39.95	0.378	21.36	0.202
83333	Kara	127.42	2.22	12.13	173.63	2210.0	12.23	1.67	1.074	38.19	0.411	19.39	0.211
	Rafal	140.58	2.75	13.13	189.87	2320.9	12.95	1.83	1.341	42.04	0.570	22.46	0.304
	Bristol	122.00	2.06	10.57	164.66	2032.1	10.90	1.51	1.028	37.56	0.390	19.28	0.199
166666	Kara	142.81	2.02	10.59	162.76	1786.8	10.82	1.47	1.150	36.73	0.424	19.08	0.220
	Rafal	150.81	2.48	11.64	175.51	2004.9	11.75	1.74	1.462	40.87	0.601	20.78	0.307
	Bristol	141.33	1.64	10.36	156.33	1682.0	10.66	1.36	1.144	35.26	0.408	17.69	0.203

* The mean values within column followed by the different letters are significant at 0.01 and 0.05 probability levels, respectively.

Table -5- The physical and chemical characters of soil filed experiments in both seasons.

seasons	2008-2009	2009-2010
physical characters		
Sand (%)	64.00	42.00
Silt (%)	20.00	35.00
Clay (%)	16.00	23.00
Texture	Sandy Loom	Silty Sandy
Chemical characters		
O.M. ($g.kg^{-1}$)	1.11	1.20
Available N (ppm)	40.22	36.12
Available P (ppm)	12.10	10.40
Available K (ppm)	110.00	118.00
Total $CaCo_3$ ($g.kg^{-1}$)	2.66	1.74
pH	7.20	7.60
E.C. mmhos/cm	0.66	0.82

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