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Agro-physiological Response of Canola (*Brassica napus* L.) to Different Planting Patterns and Stand Densities

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Abstract

Investigations to study the effect of different planting patterns and stand densities on the growth, seed yield and oil contents of canola were carried out at the agronomic research area, University of Agriculture, Faisalabad during the year 2001-02. The experiment comprised four planting patterns viz. 40 cm apart single row, paired row (60/20 cm), 40 cm apart ridge sowing and bed sowing (50/30 cm) and three stand densities viz. 10, 15 and 20 cm interplant distance. Leaf area index, number of siliquae bearing branches, number of siliquae per plant and seed yield were affected significantly by both planting patterns and stand densities while plant height, number of seeds per siliqua and seed oil percentage remained unaffected by planting patterns and stand densities. 1000-seed weight was affected significantly by planting patterns but not affected by interplant spacing. Highest seed yield (320.74 kg ha^{-1}) was obtained in 40 cm apart single rows while among stand densities 10 cm interplant spacing produced the highest seed yield (3349.32 kg ha^{-1}).

Key words: Canola, Planting patterns, Stand densities, Interplant spacing.

Introduction

Rapeseed and mustards are the second source after cottonseed contributing towards the national production of edible oil. These have remained one of the major sources of oil in the sub-continent for centuries. In the recent years the world production of rapeseed oils is exceeded only by soybean, sunflower and palm oil (FAO, 2003). Its nutritional potential remained neglected because of its undesirable smell for long time. Rapeseed and mustard varieties, which are generally cultivated in Pakistan, are high in erucic acid (40-60%) and glucosinolates (>100 micro mole g^{-1}) contents.

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The oil extracted from these varieties is not being used in the manufacturing of vegetable ghee because of traces of glucosinolates in it which interfere with the catalyst Nickel (Ni). These compounds also add typical mustard flavor to the products. Thus there was a need to develop cultivars low in erucic acid and glucosinolates to improve the oil quality and make these more desirable. Fortunately, the Canadian scientists succeeded in evolving varieties low in erucic acid (< 0.5% of seed oil) and glucosinolates (<30 micro mole g^{-1}). Such varieties were named as “CANOLA” (Canadian Oil low in Acids), “Double Zero” or “Double low” and “LEAR” (Thomas, 1986). Planting pattern is an important determinant of grain yield (Cardwell, 1982). Planting patterns affect radiation use efficiency (Tollenaar and Aguilera, 1992), and it decreases with increase in vapour pressure deficit from 0.9 to 1.7 kPa (Kiniry *et al.* 1989). Linear increase in grain yield has been reported with increasing plant density until other production factors become limiting (Arnon, 1972; Anjum *et al.* 1992). According to Sharma and Thakur (1993) sowing of *Brassica napus* L. with different row spacing was not affected significantly, but according to Gawai *et al.* (1994) seed and oil yields increased at closer spacing in *Brassica juncea*. Xie *et al.* (1998) also reported that canola performance was better at 38 cm row spacing than at 25 cm. So keeping in view the significant role of this important aspect of advanced production technology, the present study was undertaken to determine a suitable planting pattern and stand density for harvesting a rich crop of canola under given environments.

Materials and Methods

A study to determine the agro-physiological response of canola (*Brassica napus* L.) cv. Hyola-401 to different planting patterns and stand densities was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad during the year 2001-2002. The experiment was laid out in a Randomized Complete Block Design (RCBD) with factorial arrangement consisting of three replications, having a net plot size of 1.6 x 5 m.

The crop was sown on 4th October 2001, using a seed rate of 5 kg ha^{-1} with a single row hand drill. The experiment comprised four planting patterns (40 cm apart single row, 60/20 cm paired row planting, 40 cm apart single row ridge sowing and 50/30 cm bed sowing) and three stand densities (10, 15 and 20 cm interplant distance).

Nitrogen and phosphorus fertilizers were applied @ of 90 kg ha^{-1} and 60 kg ha^{-1} respectively, in the form of Urea and DAP. Half of N and full P were applied as basal dose and remaining half of the N was applied at first irrigation. First irrigation was given at the branching stage, second at the flowering stage and third and final irrigation was given at grain filling period. The crop was thinned out twice to maintain the plant to plant distance of 10, 15, and 20 cm as per treatment. The crop was kept free of weeds by manual hoeing. All other agronomic practices were kept normal and uniform for all the treatments. The crop was harvested on 20th March 2002 and left in the field for sun drying and then threshed manually. Various observations on different crop parameters were recorded by adopting standard procedures.

The data collected on various growth, yields and quality parameters of the crop were analyzed statistically using Fisher's analysis of variance technique and treatments' means were compared by using the least significant different (LSD) test at 5% level of probability (Steel and Torrie, 1984).

Results and Discussion

Leaf area index was significantly influenced by different planting patterns and stand densities (Table-1). Maximum leaf area index (2.95) was recorded in P_1 treatment where the crop was sown in 40 cm apart single row, which was statistically at par with P_3 treatment. Whereas, minimum leaf area index (2.70) was recorded in P_2 treatment, which was statistically at par with P_4 treatment, where the crop was sown in paired rows (60/20 cm) and bed sowing (50/30 cm), respectively. Stand densities also influenced leaf area index significantly. Maximum leaf area index (3.09) was observed in S_3 treatment where interplant spacing was 20 cm, which was however, statistically at par with S_2 treatment. Minimum leaf area index was noted in S_1 treatment, where the interplant spacing was 10 cm.Maximum leaf area index in S_3 treatment could be attributed to less competition between the plants for soil resources. In S_1 treatment, due to more planting density, there was more competition within the plants which reduced the leaf area index. These results are in general agreement with those published for Indian mustard by Kumar *et al.* (1997).

Data presented in Table-1 show that there was a non-significant effect on plant height of canola crop of different planting patterns and stand densities. The interaction between planting patterns and stand densities was also found to be non-significant. Huhn and Schuster (1995), also reported similar non-significant effect of plant density on plant height of winter rape.

Highest number of siliqua bearing branches (13.66) was recorded in P_1 treatment where the crop was sown in 40 cm apart lines, which was however, statistically at par with P_3 treatment. Whereas, minimum number of siliqua bearing branches (12.66) was noted in P_4 treatment, which was statistically at par with P_2 and P_3 treatments.

Similarly, stand densities also differed significantly from each other with respect to number of siliqua bearing branches. Maximum number of siliqua bearing branches plant^{-1} (14.25) was observed in S_3 treatment where interplant spacing was 20 cm, followed by S_2 treatment. Minimum number of siliqua bearing branches plant^{-1} (11.91) was noted in S_1 treatment, where the interplant spacing was 10 cm. More number of siliqua bearing branches in S_3 treatment could be attributed to less competition within the plants. In S_1 treatment, due to more dense planting density, more competition between plants reduced the number of siliqua bearing branches plant^{-1}. These results also corroborate with the findings of Pahkala *et al.* (1994). They concluded that denser plant stands produced thinner and shorter plants. When shortening occurred the number of branches decreased.

Number of siliquae plant^{-1} was significantly affected by planting patterns and stand densities and interaction between planting patterns and stand densities had also a significant effect (Table 2). Maximum number of siliquae plant^{-1} (354.99) was produced by P_1 treatment, where crop was sown in 40 cm apart single rows, followed by P_3, and P_4 treatments. Minimum number of siliquae plant^{-1} (340.81) was recorded in P_2 treatment (60/20 cm paired row planting).

In case of stand densities, maximum number of siliquae plant^{-1} (362.47) was produced in S_3 treatment where interplant spacing was 20 cm, followed by S_2 treatment. Minimum number of siliquae plant^{-1} was noted in S_1 treatment where the interplant spacing was 10 cm.

The significant interaction between planting patterns and stand densities showed that maximum number of siliquae plant^{-1} (379.66) was observed in P_1S_3 treatment, where crop was sown in 40 cm apart single rows with 20 cm interplant spacing and minimum siliquae plant^{-1} (328.27) in P_2S_1 treatment, where paired rows (60/20 cm) with 10 cm interplant spacing which was however, statistically at par with P_4S_1 and P_3S_1 treatments. These results are in line with that of Dalai *at el.* (1996). They concluded that optimum plant density produced maximum siliquae plant^{-1}.

The data in Table-1 show that number of seeds siliqua^{-1} was not affected significantly by planting patterns and stand densities. These results support the findings of Huhn and Schuster (1995). They reported that seeds per siliqua of winter rape were not affected by plant density.

The data for 1000-seed weight of canola was significantly affected by planting pattern but not by stand densities (Table-3). However, the effect of interaction between planting pattern and stand density on this parameter was also significant. The highest 1000-seed weight (4.02 g) was recorded in P_1 treatment where crop was sown in 40 cm apart single rows being statistically at par with P_2 and P_3 treatments. The highest 1000-seed weight in P_1 treatment may be attributed to better utilization of resources like nutrients. The interaction between planting patterns and stand densities shows that highest 1000-seed weight (4.42 g) was recorded in P_1 S_2 treatment (40 cm apart single row with 15 cm interspacing) which was statistically at par with P_1S_3, P_2S_3, P_3S_2 and P_3S_3 treatments and the lowest 1000-seed weight (3.26 g) in P_4S_1 treatment (50/30 cm bed sowing with 10 cm interplant spacing). These results are in line with those of Misra and Rana (1992).

Planting patterns, stand densities and interaction between them significantly affected seed yield (Table-4). In case of planting patterns maximum seed yield (3204.76 kg ha^{-1}) was obtained in P_1 (40 cm apart single row treatment) while the minimum seed yield (2979.21 kg ha^{-1}) in P_4 (bed sowing 50/30 cm) treatment. Whereas, for stand densities the treatment S_1 (10 cm interplant) produced maximum seed yield (3349.32 kg ha^{-1}) followed by S_2 (15 cm interplant) treatment. Minimum seed yield (2659.03 kg ha^{-1}) was noted in S_3 (20 cm interplant) treatment. The significant interaction between planting pattern and stand densities shows that the maximum seed yield (3408.31 kg ha^{-1}) was produced when crop was sown in 40 cm apart single rows with 10 cm interplant spacing which was statistically at par with P_1S_2 (40 cm apart single row with 15 cm interplant spacing) treatment producing the seed yield of 3398.33 kgha^{-1}. While minimum seed yield (2354.16 kg ha^{-1}) was recorded where the crop was sown at the beds (50/30 cm) alongwith 20 cm interplant spacing. These findings are in line with those of Nepalia (1991) and Chaudhri and Mankar (1991).

The data pertaining to oil content percentage as affected by different planting patterns and stand densities are shown in Table-1, which reveal that planting patterns and stand densities non-significantly affected this parameter. Similar results were also reported by Misra and Rana (1992). They reported that seed oil contents were not significantly affected by row spacing.

Table-1: Effect of planting patterns and stand densities on leaf area index, plant height, number of siliqua bearing branches plant^{-1}, number of seeds siliqua^{-1} and oil percentage of canola.

Treatments	Leaf area index (LAI)	Plant height (cm)	No. of siliqua bearing branches plant^{-1}	No. of seeds siliqua^{-1}	Oil content (%)
A. Planting Patterns					
P_1 = 40 cm apart single row	2.95 a	148.28 ^{ns}	13.66 a	30.04 ^{ns}	44.50^{ns}
P_2 = 60/20 cm paired row planting	2.70 b	151.93	12.66 b	30.01	44.92
P_3 = 40 cm apart single row ridge sowing	2.86 a	151.23	13.11 ab	29.56	44.76
P_4 = 50/30 cm bed sowing	2.71 b	146.38	12.66 b	29.83	45.23
LSD 5%	0.1348	-	0.6455	-	-
B. Stand densities					
S_1 = 10 cm PxP	2.40 b	150.37 ^{ns}	11.91 c	29.61^{ns}	45.21^{ns}
S_2 = 15 cm PxP	2.92 a	149.14	12.91 b	30.19	44.47
S_3 = 20 cm PxP	3.09 a	148.86	14.25 a	29.78	44.87
LSD 5%	0.3690	-	0.5590	-	-

Any two means not sharing a letter in common differ significantly at 5% probability.
ns = non-significant.

Table-2: Effect of planting patterns and stand densities on number of siliquae plant^{-1} of canola

Stand densities	Planting patterns				Means
	P_1 (40 cm apart single row)	**P_2** (60/20 cm paired row)	**P_3** (40 cm apart ridges)	**P_4** (50/30 cm beds row)	
S_1 (10 cm PxP)	337.52 ef	328.27 g	334.43 efg	330.25 fg	332.61 c
S_2 (15 cm PxP)	347.81 cd	339.61 de	342.33 de	340.11 de	342.35 b
S_3 (20 cm PxP)	379.66 a	355.00 c	363.91 b	351.31 c	362.47 a
Means	354.99 a	340.81 c	346.89 b	346.89 b	

L.S.D. (P=0.05): Planting pattern = 5.113, Stand densities = 4.428, and interaction = 8.856

Table-3: Effect of planting patterns and stand densities on 1000-seed weight (g) of canola

Stand densities	Planting patterns				Means
	P_1 (40 cm apart single row)	**P_2** (60/20 cm paired row)	**P_3** (40 cm apart ridges)	**P_4** (50/30 cm beds)	
S_1 (10 cm PxP)	3.43 c	3.29 c	3.34 c	3.26 c	3.33^{ns}
S_2 (15 cm PxP)	4.42 a	3.43 c	4.27 ab	3.63 bc	3.93
S_3 (20 cm PxP)	4.23 ab	3.40 abc	3.95 abc	3.62 bc	3.80
Means	4.02 a	3.37 ab	3.85 ab	3.50 b	

L.S.D. (P=0.05): Planting pattern = 0.4101 and interaction = 0.7104
ns = non significant

Table-4: Effect of planting patterns and stand densities on seed yield (kg ha^{-1}) of canola.

Stand densities	Planting patterns				Means
	P_1 (40 cm apart single row)	**P_2** (60/20 cm paired row)	**P_3** (40 cm apart ridges)	**P_4** (50/30 cm beds)	
S_1 (10 cm PxP)	3408 a	3379 ab	3324 abc	3284 c	3349 a
S_2 (15 cm PxP)	3398 a	3319 abc	3347 abc	3299 bc	3341 a
S_3 (20 cm PxP)	2807 d	2714 e	2759 de	2354 f	2659 b
Means	3204 a	3138 b	3143 b	2979 c	

L.S.D. (P=0.05): Planting patterns = 51.38, Stand densities = 44.50 and interaction = 89.00

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