Improvement in canola yield and water saving through planting methods in rice zone

Muzzamil Hussain[1], Javed Iqbal[1], Muhammad Anwar[3*], Sanaullah[1], Masood Qadir Waqar[2] and Anjum Ali[4]

[1.] Adaptive Research Farm, Gujranwala, Pakistan
[2.] Directorate of Adaptive Research Lahore, Pakistan
[3.] Directorate of Cotton Research Institute, Ayub Agricultural Research Institute Faisalabad, Pakistan
[4.] Directorate general of Adaptive Research& Extension, Department of Agriculture Government of Punjab Lahore, Pakistan
manwar1884@gmail.com

Abstract: Study was conducted to evaluate the impact of different sowing methods on the yield and yield parameters of canola in rice zone at Adaptive Research Farm, Gujranwala during rabi 2011-12 to 2013-14. Treatment included broadcasting of seed in standing water, broadcasting in wattar condition, drill sowing, ridge sowing and bed sowing. All other agronomic practices were kept uniform. The results showed that highest seed yield was achieved in ridge sowing during all the three seasons of study. On over all basis, seed yield of said treatment (1601.10 kg ha^{-1}) was higher by72, 53, 49 and 10 % than broadcasting of seed in standing water, broadcasting of seed in wattar condition, drill sowing and bed sowing respectively. The lowest yield of 928.90 kg $hectare^{-1}$ was recorded in broad casting in standing water. It was also concluded that bed planting was second high yielder but was most beneficial technique with BCR value of 4.34 followed by ridge sowing, with 3.63 BCR. Maximum water saving of 54.23% was also recorded in bed planting method. Better performance of ridge/bed sowing was all attributable to better drainage, avoidance of temporary water logging& crop lodging, vigorous crop stand and optimum irrigation management.

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Introduction

Rape and mustards are the second largest source of edible oil in Pakistan after cotton. This is a conventional source of oil which has a history in sub continent. Rapeseed and mustard are rich source of good quality oil. It has 44-46% oil; its meal has 38-40% protein with complete profile of amino acids including lysine, methionine and cystine. The meal of rapeseed is an excellent feed for animals. The improvement in processing and refining techniques have extended the use of this oil as cooking medium, salad ingredient, and in margarine. Development of canola varieties has further enhanced the use of its oil for edible purpose. Canola (Canadian Oil low in Acids) is considered healthy for human nutrition due to its lowest content of saturated fatty acids among vegetable oils (Starner *et al*. 1999). Canola can play a significant role for the enhancement of edible oil production in the country.

For profitable cultivation of canola, there is a dire need to fine tune its production technology. Sowing methods play a key role in establishing a good crop stand for desirable yield. Sarkees, (2013) evaluated the effect of different seeding rates using drill-row and broadcasting methods on growth, seed and oil yields of rapeseed. The results showed that drill-row sowing method produced seed and oil yield more than broadcasting method, particularly, at low seeding rates i.e.4 kg ha^{-1}. Seeds grown by drill-row produced the highest number of plants m^{-2}, the highest plants height and took the longest period for their flowering and seed formation; and produced a greater number of pods $plant^{-1}$ and greater weight of seed and thus, higher seed and oil yield. For getting good yield of canola under saline conditions, crop should be grown on the ridges. Champiri and baghari (2013) concluded that canola should be planted with drill keeping plant to plant distance 15cm for obtaining maximum yield.

Khan *et al*. (2000) reported that rapeseed yield and yield components were greater when crop was grown on ridges. Grain yield was higher by 45, 31, and 28% than broad cast, dill, and furrow sowing method respectively. There are some reports that sowing methods influence yield of rapeseed, Nigussie *et al*., (1996) denoted response of Tower Set-3 and S-67 varieties to method of sowing were not consistent. In 1986 it was possible to increase yields by 4% (S-67) and 30% for Tower-Sel-3 for row-sowing, while in 1990 broadcasting turned out to be more advantageous. Drill-seeded material yielded more than broadcast material seeded at the same rate especially at the lower seeding rate (Clarke *et al*., 1978). Yellowishing of plants and stunting of growth in

rapeseed and mustards after first irrigation is a major problem in rice area, due to which seed yield is badly affected. Bed planting and ridge sowing techniques can be tested for sowing of canola in rice wheat cropping especially on clayey soils to address these problems. In bed planting, crops are grown on the raised beds and irrigated by furrows. This system promotes crop intensification and diversification besides saving of irrigation water. In raised bed system, 30-40% water can be saved as compared to conventional flood irrigation practice (RWC, 2002, Mann and Meisner, 2003; Abbas *et al*., 2016; Ali *et al*., 2016; Naseem *et al*., 2015; Malook *et al*., 2016).

By executing bed planting technique, temporary water logging can be avoided, vigorous and &better crop stand can be achieved and crop lodging can be reduced. Easier weed control, seeding into relatively dry soils and savings of water are also the benefits of bed/ridge sowing. There will also be better drainage, improved rainwater conservation; and resultantly enhanced crop productivity. Bed planting is gradually becoming popular amongst the rice wheat growers as it allows light and frequent watering, needed to address terminal heat stresses due to climate change. The performance of raised bed system further improves when the system is coupled with precision laser land leveling. The present study was conducted to evaluate different sowing methods especially bed and ridge sowing techniques with reference to above mentioned problems for the improvement in yield of canola and saving of irrigation water.

Materials And Methods

An experiment was conducted to evaluate the different sowing methods including T_1-broadcasting of seed in standing water (like sowing of berseem crop), T_2-broadcasting in watter condition, T_3-drill sowing, T_4- ridge sowing and T_5-bed sowing. The study was conducted to evaluate the impact of these methods on the yield and related parameters of canola in rice zone at Adaptive Research Farm, Gujranwala during rabi 2011-12 to 2013-14. The experiment was laid out according to Randomized complete block design (RCBD) consisting of three replication having a net plot size of 10x20 m. The canola variety hyola-401 was tested in the experiment. Field was prepared in wattar condition and basal dose of fertilizer was used uniformely. In T1 seed of canola was broadcasted in standing water like sowing of berseem crop. In T2seed of canola was broadcasted in prepared field and seed was mixed by ploughing &planking the field. In T3 sowing of canola seed was done with hand driven drill in wattar condition. In T4, after broadcasting and mixing the seed, ridges were made with tractor driven ridger and distance between ridges was kept 60 cm. In T5, after broadcasting and mixing the seed, beds of 90/30 cm were made with same ridger by removing its central tine and adjusting the remaining two. Seed of canola was used @ 5 kg ha^{-1} and sowing was done during second week of October each year. Nitrogen, phosphorus and potash were applied at the rate of 90, 60 and 62 kg ha^{-1} respectively in the form of urea, DAP and SOP. Full P, K and half N was applied at sowing and other half of nitrogen was applied with first irrigation. Total three irrigations were applied to the crop. First irrigation was given at the branching stage, second at the flowering stage and third and final irrigation was given at grain filling period. Time of irrigation was recorded in each treatment. Manual hoeing was practiced to control the weeds. All other agronomic practices were kept constant. Crop was kept insect free by applying the recommended insecticides. Crop was harvested during second week of April; sun dried and threshed manually. Data on different crop parameters i.e. plant height, number of branches plant $^{-1}$, number of pods plant $^{-1}$, number of seeds pod^{-1}, thousand seed weight and seed yield were recorded by adopting standard procedures. Economic analysis was made to work out benefit cost ratio. The data were analyzed statistically using Fisher's analysis of variance technique and treatment's means were compared by using the least significant difference test (LSD) at 5% level of probability (Steel *et al*. 1997).

Results And Discussion

1. Plant Height(Cm)

Observations made on different sowing methods depicted a significant difference in plant height. Table 1 shows that maximum plant height i.e. 138.00 and130.33cm was recorded in bed sowing during 2012-13 and 2013-14 respectively. However tallest plants during 2012-13 were recorded in ridge sowing. Broadcasting of seed in standing water expressed minimum plant height i.e. 104.67, 100.67 and 97.67 cm respectively during three years. Similar results were also reported by Khan *et al*. (2000). Good crop stand in ridge sowing was also reported by Boem *et al*. (1994) and Chauhan and Singh (1993). The good crop stand in ridge and bed sowing was based on the fact that root zone was free of excessive moisture. Thus growth stunting and yellowishing of plants after first irrigation was managed. So in this technique, irrigations were regulated in such a manner that plants did not feel thirst on one hand and on other hand excess water stress was avoided, resultantly plant grew taller and healthier.

TABLE-1. Means Regarding Plant Height And Number Of Primary Branches Plant^{-1}

	Plant height (cm)			Number of primary branches plant^{-1}		
Treatments	**2010-11**	**2011-12**	**2012-13**	**2010-11**	**2011-12**	**2012-13**
T1	104.67 b	100.67 b	97.67 c	7.367 b	8.267 b	6.800 d
T2	109.00 b	101.67 b	108.33 bc	7.567 b	8.233 b	7.133 d
T3	107.67 b	107.33 b	111.00 b	7.733 b	8.433 b	8.367 c
T4	122.67 a	127.33 a	126.00 a	10.533 a	11.367 a	11.267 b
T5	119.33 a	138.00 a	130.33 a	10.933 a	11.933 a	11.700 a
LSD 0.05	9.2418	19.31	13.205	0.4855	0.2501	0.4118

2. Number of primary branches plant $^{-1}$

Number of primary branches plant $^{-1}$ is an important component which determine seed yield. Analysis of variance regarding number of primary branches plant $^{-1}$ showed a significant difference among treatments (Table 1). Bed sowing produced maximum number of primary branches plant $^{-1}$ during 2010-11,2011-12&2012-13 and its value was 10.93,11.93 and11.70 respectively. Ridge sowing was second to produce maximum number of primary branches plant $^{-1}$ (10.533, 11.367 and11.267) during three years respectively. Similar results were also reported by Khan *et al*. (2000), Singh and Verma (1993), Boem *et al*.(1994), Waseem *et al*., (2014) and Sinha (1995). It was observed that healthier plants beard more number of branches per plant. Minimum number of primary branches plant $^{-1}$ was shown in T_1 i.e.7.367, 8.367and 6.800 during three crop seasons, respectively. The better performance of bed and ridge sowing was due to better growth, better uptake of nutrients and better drainage on raised beds.

3. Number of pods plant^{-1}

Number of pods is an important yield component which determine seed yield. Analysis of variance regarding number of pods per plant showed a significant difference among treatments. Table 2 depicts that T_4 expressed highest pods plant $^{-1}$ and its value was 318.67, 422.33 and 456.67 during three seasons respectively. Bed sowing was second to produce maximum pods plant^{-1}(303.33, 391.33 and 408.33 during all the three seasons respectively. Similar results were also reported by Khan *et al*. (2000), Singh and Verma (1993), Boem *et al*.(1994) and Sinha (1995). It was observed that healthier plants having more number of branches beard more number of pods per plant. Minimum number of pods was shown in T_1 i.e.222.33, 251.67 and 349.33 during three crop seasons respectively. The better performance of bed and ridge sowing was due to better micro-environment, better uptake of nutrients and better water management on ridges and raised beds.

4. Number of seeds pod^{-1}

Number of seeds per pod is an important yield component which determines the yield performance of canola plant. Analysis of variance regarding number of seeds per pod showed a significant difference among treatments studied (Table 2). Maximum seeds per pod were observed in ridge sowing (35.000 and 39.667) followed by bed sowing (33.67 and 39.33). Ridge sowing expressed maximum number of seed per plant respectively during two seasons respectively. During 2013-14 maximum number of seeds per pod (40.33) was produced in bed sowing. Higher seed count per pod in ridge sowing was also reported by Khan *et al*. (2000); Ali *et al*., (2010) and Boem *et al*. (1994). Minimum seed per pod was observed in T_1 and showed 23.000, 22.667 and 25.000 seed per pod during three seasons, respectively. The more number of seed per pod in bed sowing &ridge sowing is attributable to appropriate moisture availability and healthy plant growth in these techniques.

TABLE-2. Means regarding number of pods plant^{-1}and number of seeds pod^{-1}

	Number of pods plant^{-1}			Number of seeds pod^{-1}		
Treatments	**2010-11**	**2011-12**	**2012-13**	**2010-11**	**2011-12**	**2012-13**
T1	222.33 e	251.67 c	349.33 c	23.00 b	22.67 c	25.00 c
T2	241.33 d	259.00 c	386.67 b	30.67 a	29.67 b	33.00 b
T3	274.67 c	271.00 c	399.33 b	29.67 a	32.00 b	36.33 ab
T4	318.67 a	422.33 a	456.67 a	35.00 a	39.67 a	39.33 ab
T5	303.33 b	391.67 b	408.33 b	33.67 a	39.33 a	40.33 a
LSD 0.05	14.873	24.327	31.192	6.1877	4.8249	6.4678

5. Thousand Seed weight (g)

Seeds size and weight is positively correlated with seed yield. Plants producing bold seed contribute to yield positively. Analysis of variance regarding thousand seed weight showed a significant difference among treatments (Table 3). Ridge sowing produced heavier seeds followed by bed sowing method. In ridge sowing, thousand seed weight was 3.737, 3.322and 3.323 followed by bed sowing 3.3633, 3.307 and 3.257 g during three seasons respectively. Minimum thousand seed weight was observed in broadcasting of seed in standing water (2.763, 29.667 and 2.917 g during three years, respectively. Similar results were also reported by Biobi *et al*., (2015), Khan *et.al*. (2000) and Hassan & Hassan (1994).

6. Seed yield

Seed yield is product of number of pods per plant, number of seeds per pod and thousand seed weight. Analysis of variance regarding seed yield showed a significant difference among sowing methods. As final outcome is seed yield, main objective of agronomists is improvement of yields by improving production technology. Present study depicts that maximum seed yield was achieved in ridge sowing method followed by bed sowing during three seasons (Table 3). Ridge sowing showed excellent results due to better growth of plants and drainage of soil. Ridge sowing expressed maximum seed yield (1273.30, 1743.30 and 1786.70 kg ha^{-1} during three years, respectively. Bed sowing followed the ridge sowing with seed yield of 1196.70, 1533.30 and 1623.30 kg ha^{-1}during three years, respectively. Minimum seed yield (796.70, 1003.30 and 986.70 kg $ha^{-1)}$ was achieved in T_1 during three crop seasons, respectively. Lower seed yield was due to the fact that in flooding, soil does not absorb the water fastly and root zone remains saturated for many days. More over during the month of December and January soil does not lose its moisture due to dew falling and mild temperature. Consequently plant growth is stunted and leaves turn yellow resulting in small plants with lesser number of pods having lesser and lighter seeds and ultimately low seed yield. Similar results were also reported by Ali *et al*., (2014ab); Kanwal *et al*., (2015); Khan *et. al*. (2000); Francois (1994); Khan *et al*. (1989); Radmann *et al*. (1994); Ramzan *et al*., (2015); Sinha (1995) and Gaffer and Ali (1990). Asoodar and Yousefi (2013) reported that yield of rapes on raised-bed planting method (3679 kg/ha) was higher than flat planting (3489 kg/ha). It has been observed that drainage in clayey soils proceeds slow after first irrigation. More over during months of December and January, soil does not lose its moisture due to dew falling and mild sun shine, Root zone remains saturated for many days and crop growth is affected severely, ultimately seed yield is decreased. On ridges and beds canola plants grow quite normally due to comparatively better drainage and warmer environment on shoulder and top of ridges &beds. Besides the lesser temporary water logging & reduced crop lodging, there is also a very good irrigation management for improved seed yield.

TABLE-3 Means regarding 1000-seed weight and seed yield

	1000-seed weight (gram)			**Seed yield (kg ha^{-1})**		
Treatments	**2010-11**	**2011-12**	**2012-13**	**2010-11**	**2011-12**	**2012-13**
T1	2.7633 b	2.9767 c	2.9167 c	796.70 d	1003.30 b	986.70 e
T2	2.8100 b	3.0933 b	3.0567 b	940.00 c	1096.70 b	1110.00 d
T3	3.0000 b	3.1500 b	3.0467 b	983.30 c	1013.30 b	1216.70 c
T4	3.7367 a	3.3423 a	3.3233 a	1273.30 a	1743.30 a	1786.70 a
T5	3.6633 a	3.3067 a	3.2567 a	1196.70 b	1533.30 a	1623.30 b
LSD 0.05	0.2757	0.1134	0.1041	53.697	147.620	61.781

7. Consumption of irrigation water

Experiment depicts that consumption of irrigation water was different in different treatments. Minimum water was consumed in bed sowing followed by ridge sowing. It has been concluded that irrigation water which is a precious and deficit input can be saved up to 54 % in bed sowing technique along with considerable increase in yield. It has been found that canola crop can be grown successfully by executing ridge and bed sowing techniques. Table-4 shows that maximum irrigation water(275mm) was consumed in T_1-broadcasting of seed in standing water an minimum (135mm) in T_5-bed sowing. Irrigation water saving was 11.86,15.25,38.94 and 54.23 % in broadcasting of seed in wattar condition, drill sowing, ridge sowing and bed sowing respectively, as compared with broadcasting of seed in standing. About 30-40% water saving in raised bed planting has also been reported by Rice Wheat Consortium, (2002) and Mann & Meisner, (2003). From this experiment, it has also been concluded that ridge and bed sowing method save irrigation water on one hand and on other hand crop is also saved from excessive irrigation and rain water. It has been observed that irrigation management through bed and ridge sowing is also

helpful in weed control. Thus benefits of these methods are multidimensional and manifolds.

TABLE -4: Water saving in different planting methods

Sr. no	Treatments	Total water used (mm)	Percent saving of water over T_1
1	T1	275	-
2	T2	260	11.86
3	T3	250	15.25
4	T4	180	38.98
5	T5	135	54.23

8. Benefit Cost Ratio

BCR was worked out to evaluate the profitability of sowing techniques discussed above. Table 5 depicts that maximum value of BCR (4.34) was observed in bed sowing method followed by ridge sowing (3.63). Minimum BCR was shown by drill sowing and its value was 0.99. It has been observed that highest yield was recorded in ridge sowing but most economical method is bed sowing. It is all due to less expenditure incurred on irrigation water in later one.

TABLE: 5 Benefit Cost Ratio for different planting methods

Treatments	Yield (KG/HA)	Increase Over T_1	Variable Cost(Rs.)	Additional Income (Rs.)	BCR
T_1	928.90	-	-	-	-
T_2	1048.90	120.00	6504	6600	1.01
T_3	1071.10	142.20	7904	7821	0.99
T_4	1601.10	672.20	10181	36971	3.63
T_5	1451.10	522.20	6620	28721	4.34

Conclusion

It was concluded that canola crop can be grown successfully in rice zone by executing the ridge and bed sowing techniques. Irrigation water and energy can also be saved up to 54% besides the increase in seed yield up to 72%. However fine tuning of these methods may enhance productivity of canola crop further in the area.

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