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Planting pattern in wheat (*Triticum aestivum*) and Indian mustard (*Brassica juncea*) crop mixture under irrigated conditions in mid-hills of North-Western Himalayas

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ABSTRACT

A field experiment was conducted during the winter season of 1990–91 to 1992–93 to study the effect of planting pattern of wheat (*Triticum aestivum* L. emend. Fiori & Paol.) and Indian mustard [*Brassica juncea* (L.) Czernj. & Cosson] under 2 wheat row spacings (22.5 and 15 cm) and as seed mixture under broadcast sowing. Wheat + Indian mustard intercropped in an 8 : 1 row combination under both wheat row spacings and mixed cropping of wheat and Indian mustard under broadcast sowing system did not show significant difference in wheat yield compared to yield of respective sole crop of wheat. All the inter- and mixed cropping treatments showed higher wheat-equivalent yields, land-equivalent ratio (LER) and benefit : cost ratio over sole crops, and the highest values of these parameters were obtained under planting pattern of wheat and Indian mustard in row ratio of 8 : 1 in both wheat row spacings, but 22.5 cm wheat row spacing proved more remunerative.

Key words: Planting pattern, Wheat and Indian mustard intercropping, Yield, Economics

Wheat and Indian mustard in inter -and mixed cropping system is widely practised under North Indian conditions to ensure higher returns and as an insurance against inclement weather conditions. Increasing the proportion of wheat rows to that of Indian mustard from 4 : 1 or 2 to 10 : 1 or 2 gave higher total yield and monetary returns and had better LER values in comparison to sole cropping (Sharma *et al.*, 1986). Apart from sole cropping, wheat and Indian mustard are widely grown as inter- and mixed crop situation in mid-hills of North-Western Himalayas. Since information on suitable planting pattern of wheat and Indian mustard under irrigated conditions are meagre for recommendation to the growers of this region, the present investigation was undertaken.

MATERIALS AND METHODS

A field experiment was conducted during winter season of 1990–91 to 1992–93 at

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experimental farm, Hawalbagh, Almora, (29°36' N and 79°40'E with an elevation of 1,250 m above mean sea-level). Nine treatments comprising wheat and Indian mustard as sole and in row proportion of 4 : 1, 6 : 1 and 8 : 1 under 2 wheat row spacings (22.5 and 15 cm) were evaluated. Besides above treatments, broadcast wheat (sole), and mixed cropping of wheat and Indian mustard in broadcast sowing (maintaining 30,000 and 45,000 Indian mustard plants/ha) were also studied during 1991–92 and 1992–93. Seeds @ 100 kg/ha for wheat for both broadcasting and line sowing as per treatment and @ 5 kg/ha for Indian mustard in lines 45 cm apart were used. Indian mustard plants were thinned at 25 days after sowing to maintain the desired planting geometries or populations. The sole wheat and intercropping treatments were fertilized @ 120 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha, whereas Indian mustard sole crop received 80, 40 and 40 kg N, P_2O_5 and K_2O/ha respectively. The experiment was laid out in randomized block design with 3 replications. Wheat cv. 'CPAN 1796' and Indian mustard cv. 'Varuna' were sown during first week of November during all the crop seasons. The soil was sandy loam, having pH 6.3, organic carbon 0.31%, available N 160 kg/ha, available P 15 kg/ha and available K 410 kg/ha.

RESULTS AND DISCUSSION

Grain yield

Yields of sole wheat under different sowing methods (line or broadcast) did not differ significantly during all the cropping seasons. Grain yields of wheat under all mixed or intercropping systems decreased significantly, except under 8 : 1 row proportion of wheat and Indian mustard planted in either 22.5 or 15 cm apart during all the years and mixed cropping treatments comprising 30,000 mustard plants/ha in broadcast wheat during 1991–92 compared to yields of their respective sole crops (Table 1). Wheat yields in all intercropping systems under both wheat row spacings did not differ significantly among themselves. Decrease in wheat yield under intercropping systems was due to lower number of rows per unit area. Sharma *et al.* (1986), Singh *et al.* (1992) and Singh *et al.* (1995) also reported similar trend.

Compared with wheat yield under pure stand, reduction in grain yield of wheat under different intercropping systems was 2.7–7.7% (mean 5.3%) in 8 : 1 and 16. 1 and 16.1–19.0% (mean 17.2%) in 4 : 1 row proportion of wheat : Indian mustard planted at the spacing of 22.5 cm, whereas under 15 cm row spacing, the reduction in wheat yield was 4.8–8.3% (mean 6.3%) in 8 : 1 and 13.5–20.2% (mean 17.9%) under 4 : 1 row proportion. More reduction of wheat yields in intercropping under 15 cm than 22.5 cm row spacing may partly be attributed to more intra-row competition coupled with adverse effect of Indian mustard canopy spread. In mixed cropping of wheat and Indian mustard under broadcast sowing, no significant difference in wheat yield was observed compared to yield of sole broadcast wheat except during 1991–92 with the treatment having Indian mustard population of 45,000 plants/ha, which may be explained on the basis that desired Indian mustard population after thinning was maintained preferentially in place where gapy stand on broadcast wheat was observed. Hence wheat crop might have not faced much adverse effect due to Indian mustard canopy. Similar results were also reported by Sharma *et al.* (1986).

The highest mustard yield was obtained under sole cropping and decreased with the reduction in its rows or population in all intercropping systems. However, differences in mustard yield under all intercropping treat-

Table 1. Wheat and Indian mustard yields under pure and intercropping systems

Treatment	Wheat yield (q/ha)				Mustard yield (q/ha)				Wheat-equivalent yield (q/ha)			
	Y_1	Y_2	Y_3	Mean	Y_1	Y_2	Y_3	Mean	Y_1	Y_2	Y_3	Mean
Wheat pure (22.5 cm)	45.68	50.12	38.52	44.77					45.68	50.12	38.52	44.77
Wheat (22.5 cm) + Indian mustard (IM) (4 : 1)	38.32	41.70	31.19	37.07	2.32	3.46	2.99	2.92	44.51	50.13	37.53	44.06
Wheat (22.5 cm) + IM (6 :1)	40.24	46.91	33.98	40.37	1.86	2.63	2.18	2.22	45.20	53.22	38.60	45.71
Wheat (22.5 cm) + IM (8 . 1)	42.15	48.76	36.27	42.39	1.36	2.47	1.95	1.93	45.77	54.78	40.41	46.98
Wheat pure (15 cm)	45.28	48.19	36.87	43.45					45.28	48.19	36.87	43.45
Wheat (15 cm) + IM (4 :1)	39.51	40.07	30.74	36.77	2.62	3.53	2.64	2.93	46.50	48.67	36.34	43.84
Wheat (15 cm) + IM (6 : 1)	39.84	44.21	34.07	39.37	2.13	2.96	2.62	2.57	45.52	51.42	39.63	45.52
Wheat (15 cm) + IM (8 : 1)	43.01	45.92	36.07	41.87	1.75	2.57	2.10	2.14	47.42	52.18	41.12	46.91
(broadcast) pure		46.83	35.30	41.07						46.83	35.30	41.07
Wheat + IM mixed broadcast (30,000 mustard plants/ha)		45.08	33.97	39.53		3.13	2.42	2.78		52.72	39.10	45.91
Wheat + IM mixed broadcast (45,000 mustard plants/ha)		42.20	32.86	37.53		4.12	2.51	3.32		52.68	38.18	45.43
IM pure					10.66	12.51	12.59	11.92	28.43	30.48	26.71	28.54
CD (P = 0.05)	4.82	4.48	4.52		1.09	1.10	1.06		4.62	4.31	4.90	

Y_1, 1990–91; Y_2, 1991–92; Y_3, 1992–93

Table 2. Land-equivalent ratio (LER) and benefit : cost ratio (BCR) under pure crop and different intercropping systems

Treatment	LER				BCR (Rs/ha)			
	Y_1	Y_2	Y_3	Mean	Y_1	Y_2	Y_3	Mean
Wheat pure (22.5 cm)	1.00	1.00	1.00	1.00	1.69	2.08	1.60	1.79
Wheat (22.5 cm) + Indian mustard (IM) (4 : 1)	1.06	1.11	1.10	1.09	1.69	2.14	1.62	1.81
Wheat (22.5 cm) + IM (6 :1)	1.06	1.15	1.06	1.09	1.68	2.18	1.65	1.83
Wheat (22.5 cm) + IM (8 : 1)	1.05	1.17	1.10	1.11	1.70	2.18	1.65	1.84
Wheat pure (15 cm)	1.00	1.00	1.00	1.00	1.63	1.73	1.31	1.56
Wheat (15 cm) + IM (4 :1)	1.12	1.11	1.10	1.11	1.63	1.92	1.47	1.67
Wheat (15 cm) + IM (6 : 1)	1.08	1.15	1.13	1.12	1.62	2.02	1.58	1.74
Wheat (15 cm) + IM (8 : 1)	1.11	1.16	1.16	1.14	1.69	2.06	1.65	1.80
(broadcast) pure		1.00	1.00	1.00		1.99	1.55	1.77
Wheat + IM mixed broadcast (30,000 mustard plants/ha)		1.21	1.15	1.18		2.16	1.66	1.91
Wheat + IM mixed broadcast (45,000 mustard plants/ha)		1.23	1.12	1.18		2.14	1.62	1.88
Mustard pure	1.00	1.00	1.00	1.00	1.48	1.74	1.52	1.58
CD (P = 0.05)	0.03	0.05	0.05		0.06	0.08	0.06	

Y_1, 1990–91; Y_2, 1991–92; Y_3, 1992–93

ments did not differ significantly among themselves. In intercropping, Indian mustard had advantage because crop is exposed to more sunlight, thereby putting wheat crop to disadvantage situation. Similar results were reported by Singh *et al.* (1992, 1995). In general, seed yield of Indian mustard in mixed cropping under broadcast wheat was higher than intercropping in rows with similar mustard population levels (6 : 1 and 4 : 1 row combinations). Mixed stand had advantage, as it was more exposed to solar radiation and had little adverse effect on wheat yield, as the desired plant population of Indian mustard preferentially was maintained in gapy stands of wheat crop. Similar results were reported by Singh *et al.* (1992).

Wheat equivalent

In general, higher wheat-equivalent yields under 6 : 1 or 8 : 1 intercropping system, were recorded than 4 : 1 intercropping system under both wheat row spacings. The highest mean wheat-equivalent yield was recorded in 8 : 1 row proportion under both the wheat row spacings, which indicates that more number of wheat rows to Indian mustard rows had positive effect in achieving higher wheat-equivalent yields.

Land-equivalent ratio

Land-equivalent ratio (LER) obtained from combined intercrop yields was always significantly higher than sole crop (Table 2). This indicated greater biological efficiency of the intercropping treatments than sole crop. The highest mean land-equivalent ratio was obtained under 8 : 1 row proportion in both the wheat row spacings. Singh *et al.* (1995) recorded the highest LER values under 9 : 1 and 6 : 2 wheat : mustard row combinations. Overall, mixed cropping of wheat and Indian

mustard (maintaining 30,000 or 45,000 Indian mustard plants/ha) under broadcast sowing was found better than other intercropping systems which had mean LER 1.18 compared with the highest being in 8 : 1 row proportion in 15 cm (1.14) and 22.5 cm (1.11) wheat row spacing.

Benefit : cost ratio

All the intercropping treatments gave higher benefit compared to pure crops (Table 2). The highest benefit : cost ratio was obtained under 8 : 1 row ratio under both wheat row spacings. Similar results were reported by Singh *et al.* (1992). More benefit per rupee invested in all intercropping systems under 22.5 cm than 15 cm row spacing was owing to lower cost of production in cutting the furrows at 22.5 cm apart than closer sowing of wheat in 15 cm row-to-row distance. In general, mixed cropping of wheat and Indian mustard under broadcast sowing recorded higher benefit : cost ratio than any intercropping system under both wheat row spacings, which was mainly due to lower cost involved in broadcast sowing compared with line sowing.

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