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Intercropping of Chickpea and Safflower with Wheat at Different Row Ratios under Conserved Soil Moisture

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Abstract: A field experiment was conducted during the winter season of 1992-93, 1993-94 and 1994-95 on clayey Typic Chromustert soil under conserved moisture conditions at Regional Research Station, Gujarat Agricultural University, Arnej to identify compatible intercrop and suitable row ratio for wheat-based intercropping system. Nine treatment combinations, involving wheat, chickpea and safflower alone, and wheat + chickpea and wheat + safflower in 1:1, 2:1 and 3:1 row ratio were tested in randomized block design with four replications. The results revealed that yield of main and intercrops was reduced in intercropping system as compared to sole crop system of respective crops. However, the wheat-equivalent yield was remarkably increased in intercropping system involving safflower as an intercrop. The reverse was true in case of intercropping treatments involving chickpea as an intercrop. On an average, wheat + safflower (3:1) secured the highest wheat-equivalent yield (1353.05 kg ha^{-1}), gross income (Rs. 10801 ha^{-1}) and cost: benefit ratio (1:3.24) among all the treatments under study.

Key words: Intercropping, rainfed wheat, conserved moisture.

Wheat and gram are major traditional rabi crops grown on conserved soil moisture in Bhal and Coastal Agro-climatic Zone of Gujarat State. Safflower performs better under conserved moisture conditions of this zone. intercropping can give better yield as compared to sole crops (Mandal *et al.*, 1986 and 1987). Selection of compatible intercropping system for sustainability and risk minimizing under conserved moisture farming is the need for coastal region. Present investigation was, therefore, taken up to identify compatible intercrop and suitable row ratio for wheat-based cropping system.

Materials and Methods

Wheat-based intercropping experiment was carried out at the research farm of Regional Research Station, Gujarat Agricultural University, Arnej, during winter (rabi) season of 1992-93, 1993-94 and 1994-95 on medium black soil under conserved moisture conditions. The nine treatments involving wheat (var. GW-1), chickpea (var. Chaffa) and safflower (var. Bhima) alone, and wheat + chickpea and wheat + safflower in the row ratio of 1:1, 2:1 and 3:1 at a spacing of 30 cm were evaluated in a randomized block design with four replications. The soil was low in available nitrogen, medium in phosphorus and high in available potash with pH 8.2. The crops were sown on 5th November, 3rd November and 28th October during 1992, 1993 and 1994, respectively. Seed rate for sole crop of wheat (durum), chickpea and safflower was 60, 40 and 20 kg ha^{-1}, respectively. For intercrops, proportional seed rate was maintained according to the row ratios. The

Table 1. Yield of different intercropping treatments (kg ha^{-1})

Treatment	1992-93		1993-94		1994-95		Average	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Wheat alone	1194	1875	825	1142	782	1258	934	1425
Chickpea alone	661	407	636	612	469	656	588	558
Safflower alone	1009	–	856	–	762	–	876	–
Wheat +	645	1051	262	385	530	894	479	776
Chickpea (1:1)	216	146	390	391	227	318	278	285
Wheat +	877	1421	516	699	622	1083	672	1068
Chickpea (2:1)	163	123	245	224	151	213	186	168
Wheat +	955	1519	496	634	692	1133	714	1095
Chickpea (3:1)	104	65	184	189	105	146	131	134
Wheat +	494	792	185	237	356	688	358	572
Safflower (1:1)	540	–	665	–	539	–	581	–
Wheat +	608	986	268	416	507	884	461	762
Safflower (2:1)	492	–	683	–	324	–	500	–
Wheat +	783	1215	272	402	568	1032	541	883
Safflower (3:1)	573	–	901	–	557	–	677	–

rainfall received during 1992, 1993 and 1994 was 620, 524 and 876 mm, respectively. Post-monsoon rain was not received in any of the years.

Results and Discussion

Performance of wheat

Grain yield of wheat was reduced in the intercropping system during individual years and on pooled basis as compared to sole crop of wheat (Table 1). The reduction was of lower magnitude when chickpea was intercropped with wheat. On the other hand remarkable improvement in grain yield of wheat was noticed with increase in number of wheat row from single to three rows, irrespective of the type of intercrops. Gupta and Pradhan (1988) and Hiremath *et al.* (1991) also reported such variation in grain yield due to variation in wheat row proportion in wheat + oilseed intercropping.

Performance of intercrops

The results presented in Table 1 indicate that the yield of intercrops was reduced as compared to the yield of sole crop. On an average chickpea as an intercrop produced 277.67, 186.25 and 131.00 kg ha^{-1} grain in 1:1, 2:1 and 3:1 row ratio, respectively, as against 588.42 kg ha^{-1} of chickpea alone, whereas safflower produced 581.25, 499.58 and 676.92 kg seed ha^{-1} in 1:1, 2:1 and 3:1 row ratio, respectively, as against 875.58 kg $ha^{-1}$of safflower alone. Thus in the intercropping system the reduction in yield of chickpea due to wheat was higher as compared to that of safflower. This might be due to the better ability of safflower to utilize more space and moisture to optimize yield.

Wheat-equivalent yield

In general, intercrop treatments involving safflower achieved higher wheat equivalent

Table 2. Phenothermal index (°C day day^{-1}) during various phenophases in brassicas

Treatments	1996-97						1997-98					
	P_1	P_2	P_3	P_4	P_5	P_6	P_1	P2	P_3	P_4	P_5	P_6
Sowing date												
D_1	17.3	18.1	13.9	9.4	6.8	9.5	9.5	6.4	6.1	8.0	11.0	15.6
D_2	19.5	14.1	8.3	7.4	7.0	12.1	8.9	5.7	8.4	10.9	11.4	16.8
D_3	15.4	9.8	7.9	5.9	8.9	14.2	4.5	6.4	10.2	11.2	12.0	18.3
C.D. at 5%	0.2	0.1	0.4	0.3	0.2	0.5	0.3	0.1	0.6	0.9	0.5	1.0
Plant density												
S_1	17.4	14.0	10.0	7.6	7.5	12.0	7.6	6.2	8.3	10.0	11.6	17.1
S_2	17.4	14.0	10.0	7.5	7.6	11.9	7.6	6.1	8.1	10.1	11.4	16.7
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Cultivar												
V_1	17.4	13.9	10.1	7.5	7.8	12.6	7.6	6.2	8.2	10.6	11.2	16.7
V_2	17.4	13.9	10.0	7.4	7.6	12.3	7.6	6.2	8.4	10.5	11.7	18.1
V_3	17.3	13.7	9.4	7.2	8.1	13.1	7.6	6.3	8.9	10.5	12.4	19.3
V_4	17.4	14.4	10.7	8.0	6.8	9.8	7.7	5.9	7.3	8.7	10.6	13.4
C.D. at 5%	NS	0.2	0.4	0.3	0.2	0.5	NS	0.1	0.5	0.7	0.4	1.0

during P2. TUE values during various phenophases in 1997-98 were lower than TUE values in 1996-97 (Table 1). An extraordinary delay in sowing of the crop due to abnormal weather conditions was the main reason for this drop of TUE. The TUE was reduced significantly with delay in sowing during both the years mainly due to low biomass production. Kar (1996) obtained similar results in Indian mustard. The plant spacing had no effect on TUE as spacing had no effect on biomass accumulation and accumulated thermal units. Among the cultivars, TUE was the highest in cv. RH-30, followed by Laxmi; it was lowest in cv. BSH-1 during 1996-97.

Phenothermal index computed for different treatments during both the years is given in Table 2. In 1996-97 the highest phenothermal index was recorded during P1 phenophase (sowing to emergence), followed by P2, and it was the lowest in P4 or P5. However, in 1997-98, the phenothermal index was highest during P6 phenophase (end of seed filling to maturity) and it can be attributed to the occurrence of higher thermal regime during this period. Kar (1996) earlier reported similar results for mustard crop. The phenothermal index decreased significantly with delayed sowing during vegetative and early reproductive phases in both the years. However, during reproductive phase phenothermal index increased significantly with delayed sowing. Plant spacing had no failed to cause any significant influence on phenothermal index.

The phenothermal index of emergence period (P1) was almost similar for all the cultivars under study. However, by the time crop approached the 50% flowering stage, the value of this index was the highest in BSH-1 and the lowest in Laxmi. The fast growth in BSH-1 during initial phases led to such variations. For crop maturity, the highest phenothermal index was recorded in Laxmi and it was lowest in

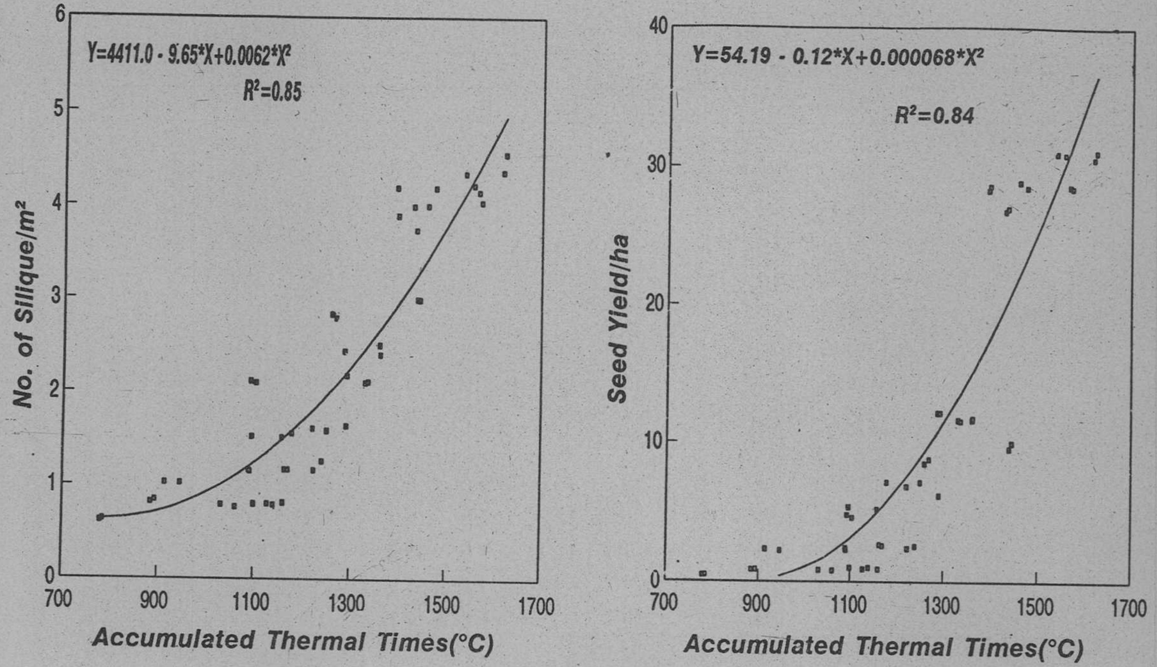

Fig. 1. Relationship between accumulated thermal time and yield and yield attributes in brassicas.

BSH-1 during two years of study. The late sowing of crop and low temperatures during entire crop growing season in 1997-98 resulted in poor values of phenothermal index.

The number of seeds/siliqua increased linearly with increase in heat units (Fig. 1). The 100-seed weight followed the trend of sigmoid growth curve as the rate of increase was slow initially (800 to 1000°C day thermal time); which recorded a decline after 1500°C day with a fast increase in the middle. The number of siliquae m^{-2} followed the parabolic growth curve with continuous increae in thermal time. The seed yield m^{-2} followed the trend of parabolic growth curve. Rolter (1974) reported similar results in winter rape and Patel and Mehta (1987) in mustard.

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