

## Effect of seed ratio on barnyard millet (*Echinochloa frumentacea*) - based mixed cropping system

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### ABSTRACT

A field experiment on mixed cropping during rainy (*kharif*) season 1993 and 1994 in barnyard millet (*Echinochloa frumentacea* Link) was conducted under rainfed conditions. The grain yield of barnyard millet was highest (13.06 q/ha) in sole crop. It was decreased in all the mixed cropping patterns except barnyard millet + soybean [*Glycine max* (L.) Merr.] in 90 : 10% seed mixture which recorded the grain yield of 11.78 q/ha. Highest land-equivalent ratio (1.45) and barnyard millet equivalent (23.97 q/ha) were also recorded under the same treatment.

**Key words:** Barnyard millet, Seed ratio, Mixed cropping

Barnyard millet, a common rainfed crop of hills of Uttar Pradesh, is rarely raised as a sole crop. A number of other crops, i.e. pulse and foxtail millet, are grown mixed with it. Barnyard millet along with soybean is a better intercropping system (Prakash and Koranne, 1987). Ricebean, horsegram and French bean or *rajma* as intercrop increase the grain yield of small millet (Singh and Arya, 1988). In view of the nature of feeding and growth pattern of both the main and mixed crops plant population especially seed ratio may be one of the major factors for increasing the yield of each crop. Since information on seed mixture of different crops in mixed cropping with barnyard millet is very scanty, present study was undertaken to find out the proper seed ratio for mixed cropping of barnyard millet with pulses.

### MATERIALS AND METHODS

A field experiment was conducted at Hill campus, Ranichauri, Tehri Garhwal, Uttar Pradesh, during rainy (*kharif*) season 1993 and 1994 under rainfed conditions. Eleven treatment combinations (Table 1), consisting of 4 seed ratios of 3 crops, viz. barnyard millet, soybean and ricebean, were tested in randomized block design with 3 replications.

The soil was silty clay loam, with pH 5.4. It was low in available nitrogen (150-170 kg/ha) and phosphorus (8.6-9.5 kg/ha), while rich in available potassium (410-425 kg/ha). The general recommendations of seed rates for barnyard millet, soybean and ricebean was 10, 70 and 30 kg/ha respectively. 'VL 29' barnyard millet was sown mixed with 'Bragg' soybean and 'Local' ricebean on 19 and 24 June in 1993 and 1994 respectively. The ex-

Table 1. Effect of different treatments on yield-contributing characters of barnyard millet, soybean and ricebean

Treatment	Barnyard millet						Pulse					
	Effective tillers/m		Grain weight/ear (g)		1,000-grain weight (g)		Plant stand/m		Pods/plant		Grain weight/plant	
	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994
Sole barnyard millet (BM)	34.5	38.2	4.47	4.23	3.98	4.17						
Sole soybean (S)							9.3	10.8	27.4	20.3	16.0	16.8
Sole ricebean (R)							8.7	9.5	32.1	26.4	13.3	13.8
BM 100% + S 10%	31.7	36.0	4.40	4.00	4.00	4.13	1.8	1.7	16.3	13.3	8.4	9.4
BM 100% + R 10%	30.0	35.2	4.20	4.07	3.78	4.00	1.7	1.5	20.1	15.2	9.9	8.9
BM 90% + S 10%	28.8	32.8	4.10	3.90	3.85	4.10	2.2	2.0	18.7	17.8	11.1	10.0
BM 90% + R 10%	26.2	31.2	3.80	3.67	3.95	3.93	2.0	1.7	23.0	20.0	10.0	9.8
BM 80% + S 20%	23.8	29.7	4.00	3.50	3.90	4.00	3.0	3.2	21.3	18.1	13.8	12.3
BM 80% + R 20%	23.2	28.5	3.50	3.37	3.80	3.83	2.8	3.0	23.2	23.8	10.9	10.8
BM 70% + S 30%	22.5	27.7	3.70	3.50	3.87	3.77	3.5	3.8	24.1	19.4	15.0	13.2
BM 70% + R 30%	21.5	28.0	3.40	3.33	3.75	4.03	3.3	3.6	28.3	24.4	12.0	11.5
CD (P = 0.05)	3.6	6.0	0.49	0.57	NS	NS	1.7	2.0	6.0	5.4	3.1	4.0

**Table 2.** Effect of different treatments on the yield and land-equivalent ratio of sole and mixed crop of barnyard millet.

Treatment	Barnyard millet yield (q/ha)		Pulse yield (q/ha)		Barnyard millet equivalent yield (q/ha)			Land-equivalent ratio (LER)	
	1993	1994	1993	1994	1993	1994	Mean	1993	1994
Sole barnyard millet (BM)	12.22	13.89			12.22	13.89	13.06	1.00	1.00
Sole soybean (S)			10.00	11.11	23.80	24.44	24.12	1.00	1.00
Sole ricebean (R)			8.33	8.89	15.86	16.00	15.93	1.00	1.00
BM 100% + S 10%	10.00	11.11	4.44	5.00	20.57	22.11	21.34	1.27	1.30
BM 100% + R 10%	8.89	10.00	4.11	3.89	17.50	17.00	17.25	1.23	1.16
BM 90% + S 10%	11.11	12.44	5.11	5.55	23.28	24.65	23.97	1.47	1.42
BM 90% + R 10%	8.33	9.00	5.00	5.00	17.85	18.00	17.93	1.32	1.24
BM 80% + S 20%	7.22	8.33	6.33	6.67	22.29	21.15	21.72	1.19	1.22
BM 80% + R 20%	6.67	7.22	6.11	5.67	18.31	17.43	17.87	1.28	1.17
BM 70% + S 30%	6.22	5.88	6.67	7.78	22.10	22.99	22.55	1.18	1.14
BM 70% + R 30%	6.11	5.78	6.11	6.55	17.75	17.57	17.66	1.26	1.17
CD (P = 0.05)	1.60	1.91	1.80	1.81				0.17	0.19

Market rates (Rs/q); Barnyard millet, soybean and ricebean; 210, 500 and 400 in 1993; and 250, 550 and 450 in 1994

perimental site was situated at 1,850 m mean sea-level on north facing. The rainfall received during crop season was 906.3 mm in 1993 and 837.6 mm in 1994. Recommended doses of fertilizers were applied basal dressing to each of the sole crop of barnyard millet (40, 20 and 20 kg N, P and K/ha) and pulse crops (20, 40 and 20 kg N, P and K/ha). The mixed cropping treatments were supplied with 20, 40 and 20 kg N, P and K/ha. An additional dose of N @ 20 kg/ha was also side-dressed in the rows of barnyard millet at tillering to the mixed cropping treatments. The seed mixtures of all the crops were sown broadcast. Barnyard millet crop was harvested on 28 and 26 October, soybean on 3 and 2 November and ricebean on 16 and 12 November in 1993 and 1994 respectively. Land-equivalent ratio of barnyard millet and pulse was worked out (Willey, 1979). Barnyard millet equivalent was calculated on the basis of support prices of all the crops in respective years.

## RESULTS AND DISCUSSION

### *Yield-contributing characters*

Seed ratio of barnyard millet and the mixed crops had a significant effect on all the yield-contributing characters of barnyard millet except 1,000-grain weight (Table 1). The maximum effective tillers and grain weight/ear were recorded in the sole crop, followed by seed ratio of 100 : 10 and 90 : 10 of main and either of the mixed crops. Narrowing the seed ratio from 90 : 10 to 70 : 30 had an adverse effect on almost all the characters.

Seed ratio under mixed cropping had a significant effect on their plant stand/m and other yield-contributing characters and maximum plants/m, pods/plant and grain weight/plant were recorded in sole crop of each of the mixed crop, i.e. soybean and ricebean, with recommended seed rate (Table 1). In different mixed cropping treatments, plants/m behaved as per the ratio of 2 crops. The pods/plant, grain weight/plant and plants/m of

pulse crops were, however, found increased with every increase in seed ratio of mixed crops from 10 to 30% and barnyard millet + soybean and barnyard millet + ricebean each at 70 : 30% seed ratio proved at par with their sole crops, followed by 80 : 20% seed ratio. Pods/plant and grain weight/plant were also recorded higher in the 70 : 30% seed ratio of barnyard millet + soybean and barnyard millet + ricebean.

### *Grain yield*

The seed ratio of barnyard millet and mixed crops had a significant effect on the grain yield of barnyard millet (Table 2). The grain yield of barnyard millet was highest in sole crop. The yield of barnyard millet decreased in all the mixed cropping treatments except barnyard millet + soybean (90 : 10). In general, the decrease was of higher order in barnyard millet + pulse in 70 : 30% seed mixture. Among the different mixed cropping system, the maximum grain yield was obtained under barnyard millet + soybean at 90 : 10% seed rate, which was 78.62 and 111.56% higher than barnyard millet + soybean at 70 : 30% seed mixture, respectively, during 1993 and 1994. The higher grain yield of barnyard millet with soybean was attributed by maximum effective tillers and grain weight/ear. Barnyard millet + ricebean at 100 : 10 and 90 : 10% seed mixture also gave higher yield than their 70 : 30% seed mixture. These results are in conformity with the results of Singh and Arya (1994).

The grain yield of soybean and ricebean was adversely affected by the mixed cropping. The sole crop of soybean and ricebean gave higher seed yield of 10.00 and 11.11 q/ha, 8.33 and 8.89 q/ha in 1993 and 1994 respectively (Table 2). In mixed cropping the seed yield of soybean and ricebean were recorded higher with the increasing seed ratio of pulse crop in each combination and the maximum seed

yield was recorded with barnyard millet + soybean and barnyard millet + ricebean both at 70 : 30% seed mixture, followed by 80 : 20% seed mixture.

### **Economic productivity**

All the intercropping systems gave higher total productivity (barnyard millet equivalent) than sole barnyard millet (Table 2). Barnyard millet + soybean intercropping system gave higher mean barnyard millet equivalent. The increase in total productivity over sole crop of barnyard millet was 90.51, 77.47 and 83.61% during 1993, 1994 and on mean basis respectively. This was mainly owing to additional advantage of yields of intercrops. Barnyard millet equivalent was also recorded higher in barnyard millet + ricebean in all the seed mixtures. Similar results were also obtained by Prakash and Koranne (1987) and Singh and Arya (1994).

### **Land-equivalent ratio**

Mixed cropping of barnyard millet with

soybean was found more remunerative than that of sole crop of barnyard millet, soybean and ricebean. The highest land-equivalent ratio was obtained with barnyard millet + soybean in 90 : 10% seed mixture, followed by barnyard millet + soybean (100 : 10) and barnyard millet + ricebean in 90 : 10% seed mixture (Table 2). In general, all the mixed cropping systems gave 16–45% higher land-equivalent ratio than their sole crop on mean basis.

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