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# Productivity potential and economics of maize (*Zea mays*) and soybean (*Glycine max*) intercroping patterns under rainfed low hill or valley situation of Uttaranchal

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## ABSTRACT

A 3-year field study was conducted during rainy (*kharif*) season of 1993–95 to evaluate different planting patterns of maize (*Zea mays* L.) and soybean [*Glycine max* (L.) Merr.] intercropping. All the intercropping patterns were superior in terms of maize-equivalent yield and income-equivalent ratio (IER) values to sole crops. All the intercropping patterns except, 1 additional maize row after every 2 rows of soybean (1:2) also recorded higher monetary returns than sole crops. Among different intercropping patterns of maize and soybean, paired maize rows (either 30/90 or 45/90 cm)+2 rows of soybean gave the highest total yield, maize-equivalent yield, IER value, net return and benefit : cost ratio. The maximum value of relative net return (RNR) over sole maize was computed under paired maize rows (45/90cm)+2 rows of soybean.

***Key words*** : Productivity potential, Intercropping pattern, Maize, Soybean, Hill or Valley situation

Soybean is an important crop of lower Himalyan region and is generally grown as mixed crop with maize. This system of growing soybean and maize together is less efficient because of improper spatial arrangement. Intercropping is the only option to increase the cropping intensity and resource utilization through introduction of some variable planting patterns in this region (Pandey *et al.*, 1999). Intercropping not only provides certain insurance against biotic and environmental stresses but also gives extra yield advantage by simple expedient of growing crops (Willey, 1979). Paired row technique is a simple way of exploiting land resources to harness the maximum yield advantage in intercropping system. Since information on suitable planting pattern of maize and soybean intercropping in this region is meagre, the present investigation was undertaken.

## MATERIALS AND METHODS

A 3-year field study was conducted during 1993–95 at Research Station, Majhera (20° 28'N, 79° 32'E and 900 m mean sea-lenel, of the University. The soil was sandy loam in texture, having high organic carbon (0.82%) and available potassium (564 kg $K_2O$/ha) but medium available phosphorus (59.14 kg $P_2O_5$/ha) with pH 5.9. A set of 7 treatments, comprising sole crops of maize and soybean and their intercorpping patterns in paired maize (30/90 cm) + soybean in 2:1 and 2:2 row ratios, paired maize (45/90 cm) + soybean in 2:2 row ratio; 1 additional maize row after every 2 rows of sole soybean in (45 cm) and maize (60 cm) + soybean (45 cm) in 2:1 row ratio, was laid down in randomized block design with 4 replications. Crops were planted in lines as per treatment. Seeds of maize (cv. 'Navin') and soybean (cv. 'PK 564') were used @ 20 and 75 kg/ha respectively. Plantings were done on 3, 1 and 28 July during 1993, 1994 and 1995 respectively. Sole maize and all intercropping patterns, except sole soybean and 1 additional maize row after every 2 rows of sole soybean (45 cm), were fertilized with recommended dose of maize (90:60:40 kg N:$P_2O_5$ : $K_2O$/ha respectively) in schedule of half N and total phosphorus and potassium at planting and remaining N at 25 days after sowing. Sole soybean and 1 additional maize row after every 2 rows of sole soybean were fertilized @ 20:80:40 kg of N : $P_2O_5$: $K_2O$/ha respectively at the time of planting. During 1993, 1994 and 1995 the crop received total rainfall of 872, 625 and 658 mm respectively. The data of 3 years were analysed and the comparisons were made on the basis of pooled maize-equivalent yield, income-equivalent ratio and economics.

## RESULTS AND DISCUSSION

*Yield:* Maize yield under all the intercropping patterns was significantly lower than sole stands in all the years; however, the magnitude of reduction varied among different intercropping patterns (Table 1). Among different intercropping patterns, paired maize rows (30/90 cm) + soybean (2:1 row ratio) being at par with paired maize rows + soybean (2:2 row ratio) in 30/90 or in 45/90 cm recorded significantly higher maize yield than other planting patterns. More number of maize plants/unit area and lesser competition for space and nutrients under paired maize rows planting geometry might be the probable reason for higher maize yield under this system. Higher yield of maize under sole stand than intercropping was also reported by Khola *et al.* (1999).

Soybean yield under all the intercropping patterns also decreased significantly compared with the sole soybean. This indicated that inter-specific competition in intercropping was more than intra- specific competiton of sole stand. Among different intercropping patterns, paired maize rows in 30/90 or in 45/90 cm + soybean (2:2 row ratio) gave significantly higher pooled soybean yield than other intercropping patterns. Both these planting patterns recorded 42.3 and 43% less pooled grain yield of soybean than sole stand.

Mean total yield (maize + soybean) of the system was the maximum in paired maize rows (30/90 cm) + soybean (2:2 row

**Table 1.** Grain yield of crops and maize-equivalent yield as influenced by intercropping patterns of maize and soybean

| Treatment | Row ratio | Maize grain yield (q/ha) | | | | Soybean seed yield (q/ha) | | | | Total mean yield of system maize + soybean (q/ha) | Maize-equivalent yield (q/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1993 | 1994 | 1995 | Pooled (q/ha) | 1993 | 1994 | 1995 | Pooled (q/ha) | | |
| Sole maize (60 cm) | | 25.2 | 26.9 | 27.9 | 26.7 | | | | | 26.7 | 27.0 |
| Sole soybean (45 cm) | | | | | | 13.4 | 16.2 | 15.8 | 15.1 | 15.8 | 30.2 |
| Paired maize (30/90 cm) + soybean | 2:1 | 23.2 | 23.8 | 20.5 | 22.5 | 5.0 | 3.6 | 8.2 | 5.6 | 28.1 | 33.7 |
| Paired maize (30/90 cm) + soybean | 2:2 | 21.4 | 21.2 | 19.4 | 20.9 | 6.9 | 11.2 | 9.0 | 8.7 | 29.6 | 38.5 |
| Paired maize (45/90 cm) + soybean | 2:2 | 19.4 | 20.6 | 22.2 | 20.7 | 5.3 | 11.7 | 8.7 | 8.6 | 29.3 | 37.9 |
| One additional maize row after every 2 rows of soybean | 1:2 | 19.2 | 19.4 | 16.6 | 18.6 | 8.2 | 5.3 | 5.4 | 6.4 | 25.0 | 31.4 |
| Maize (60 cm) + soybean (45 cm) | 2:1 | 19.7 | 21.5 | 17.8 | 19.3 | 5.6 | 12.7 | 4.8 | 7.7 | 27.0 | 34.8 |
| CD (P = 0.05) | | 4.05 | 1.63 | 2.61 | 2.78 | 2.00 | 1.23 | 3.80 | 1.40 | | 3.02 |

ratio) intercropping patterns, followed by intercropping patterns of paired maize rows 45/90 + soybean (2:2) and paired maize rows 30/90 cm + soybean (2:1 row ratio). Both these planting patterns recorded 29.3 and 28.1 q/ha mean total system yield respectively. Sole soybean gave the lowest total yield. Lower yielding potential of soybean than that of maize might be the reason of lower total yield of the system under sole soybean.

### *Maize-equivalent yield*

Significant variations in mean maize equivalent in different intercropping patterns of maize and soybean were recorded over their respective sole stands. All the intercropping patterns of maize and soybean as well as sole soybean had more maize–equivalent yield compared with sole maize. Among intercropping patterns, paired maize rows (30/90 cm) + soybean (2:2 row ratio) recorded the maximum maize-equivalent yield which being at par with paired maize rows (45/90) + soybean (2:2 row ratio) gave significantly 14.2, 22.6 and 10.6% higher yield than paired maize rows (30/90 cm) + soybean (2:1), 1 additional maize row after every 2 rows of soybean (1:2) and maize (60 cm) + soybean (45 cm) in 2:1 row ratio respectively. Higher maize-equivalent yields under various intercropping patterns of maize and soybean may be owing to better utilization of resources than sole stand. The results support those of Mahapatra and Pradhan (1992) and Sharma *et al* (1998).

### *Income-equivalent ratio (IER)*

It was always higher under intercropping patterns than the sole stand, indicating an advantage of all the intercropping patterns

**Table 2.** Income-equivalent ratio and economics as influenced by planting patterns of maize and soybean

| Planting pattern | Row ratio | Income equivalent ratio | | | | Gross return pooled (Rs/ha) | Net return pooled (Rs/ha) | Benefit: cost ratio | Relative net return over sole maize |
|---|---|---|---|---|---|---|---|---|---|
| | | 1993 | 1994 | 1995 | Pooled | | | | |
| Sole maize (60 cm) | | 1.0 | 1.0 | 1.0 | 1.0 | 13.510 | 5,760 | 1,79 | |
| Sole soybean (45 cm) | | 1.0 | 1.0 | 1.0 | 1.0 | 15.140 | 7,330 | 1.93 | 1.93 |
| Paired maize (30/90 cm) + soybean | 2:1 | 1.31 | 1.07 | 1.26 | 1.21 | 16.780 | 8,590 | 2.04 | 2.45 |
| Paired maize (30/90 cm) + soybean | 2:2 | 1.39 | 1.42 | 1.26 | 1.36 | 19.350 | 10,770 | 2.25 | 2.5 |
| Paired maize (45/90 cm) + soybean | 2:2 | 1.19 | 1.42 | 1.36 | 1.34 | 19.140 | 10,740 | 2.27 | 2.63 |
| One additional maize row after every 2 rows of soybean | 1:2 | 1.42 | 1.02 | 1.05 | 1.17 | 15,710 | 6,480 | 1.77 | 2.54 |
| Maize (60 cm) + soybean (45 cm) | 2:1 | 1.21 | 1.52 | 0.89 | 1.2 | 17,420 | 9,360 | 2.15 | 2.43 |
| CD (P = 0.05) | | 0.19 | 0.10 | 0.11 | 0.09 | 2,210 | 1,615 | 0.16 | |

Prevailing market rates of grain (Rs/q) : Maize (500) and soybean (1,000)

of maize and soybean over sole crops. Significantly higher IER values under paired maize rows (in either 30/90 or 45/90 cm) + soybean (2:2 row ratio) implied that both these 2 patterns were found to be more biologically sound in utilizing the area and other resources compared with their intercropping patterns. Besides these, paired maize (30/90 cm) + soybean (2:1 row ratio) was also found promising for high IER value (1.21)

### *Economic feasibility*

The paired maize rows (30/90 cm) + soybean (2:2) and paired maize rows (45/90 cm) + soybean (2:2) intercropping patterns produced the maximum and statistically identical gross and net returns and benefit : cost ratio. Among different intercropping patterns, 1 additional maize row after every 2 rows of soybean (1:2) recorded the lowest gross and net returs, but was superior to sole maize. Relative net return (RNR) over the sole maize was the highest under intercropping pattern of paired maize rows (45/90 cm) + soybean (2:2). Variations in different economic indices under different intercropping patterns were also reported by Rafey and Prasad (1996) and Pandey *et al.* (1999).

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