GROWTH AND ECONOMICS OF SOYBEAN AND MILLETS IN INTERCROPPING SYSTEMS

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Abstract

The field experiment was conducted at Agricultural Research Station Bailhongal, Belagavi district under University of Agricultural Sciences, Dharwad (Karnataka) to study on growth and economics of soybean and millets in intercropping systems during kharif 2016. The experiment was laid out in Randomized Block Design with three replications. Treatment details are as follows,T_1 - Soybean + foxtail millet (2:1), T_2 - Soybean + foxtail millet (4:2) , T_3 - Soybean + finger millet (2:1), T_4 - Soybean + finger millet (4:2) , T_5 - Soybean + little millet (2:1), T_6 - Soybean + little millet (4:2), T_7 - Sole crop of soybean, T_8 - Sole crop of foxtail millet, T_9 - Sole crop of finger millet and T_{10} - Sole crop of little millet. The results concluded that, intercropping systems, higher total dry matter plant^{-1} of soybean was recorded in 4:2 row ratio of soybean + foxtail millet (17.0 g). It was on par with 2:1 row ratio of soybean + foxtail millet (16.17 g) and 2:1 row ratio of soybean + finger millet (15.40 g). Significantly lower total dry matter plant^{-1} was recorded in 2:1 row ratio of soybean + little millet in (14.40 g). Further, At 30 DAS, significantly higher total dry matter accumulation of millets was recorded in sole crop of foxtail millet (9.09 g) compared to their yield in intercropping systems. It was on par with 4:2 row ratio of soybean + foxtail millet (8.50 g) and 2:1 row ratio of foxtail millet (7.91 g). Significantly lower total dry matter plant^{-1} was recorded in intercropping of soybean + little millet in 4:2 row ratio (1.75 g). A similar trend of total dry matter accumulation in 30 cm row length of millets was also recorded at 60, 90 DAS and at harvest. With respect to economics, among the intercropping systems, significantly higher gross and net returns was recorded in 4:2 row ratio of soybean + foxtail millet (Rs. 96,403 ha^{-1} and Rs. 68,457 ha^{-1} respectively) and it was on par with 2:1 row ratios of soybean + foxtail millet (Rs. 94,724 ha^{-1} and (Rs. 66,779 ha^{-1} respectively). The lowest gross and net returns was recorded in 2:1 row ratio of soybean + little millet (`Rs. 82,199 ha$^{-1}$ and `Rs. 54,115 ha^{-1} respectively).

***Key words**: Growth, Millets, Economics, Intercropping, Soybean*

Introduction

An intercropping agriculture system is the cultivation of two or more crops simultaneously on the same field. The major objectives of intercropping are produce an additional crop, optimize the use of natural resources and stabilize the yield of crops. From several studies, it is clear that yield of cereal component is usually less affected by component crop densities and manipulation of spacing between component crop, yield and monetary advantage in intercropping can be possibly achieved by the selection of crop, manipulation of plant population and row arrangement.

Soybean (Glycine max) is a one of the most important legume crop in the world and it is also called Golden bean or Miracle crop, based on its multiple uses. Its importance for sustainable agriculture is reflected in the ability to reduce soil carbon and nitrogen loses thus improving soil fertility and yields. Also, the ability of soybean to accumulate nitrogen enabled it to become a plant with high nutritive value for food and feed. The highest protein content (40%), richness in oil, vitamins and minerals makes soybean being harmonized crop for combining with cereals. Soybean is a major oil seed crop of the world grown in an area of 121.1 million hectare with production of 340.8 million tonnes and productivity of 2,810 kg ha^{-1} (Anon., 2016). In world, it is being cultivated mainly in USA, Brazil, China, Argentina and India. In India, it is grown over an area of 10.02 million hectare with production of 114.9 million tonnes and productivity of 1,047 kg ha^{-1} (Anon., 2016). On global basis minor millets are cultivated with an area of 4.17 million hectare with an annual production of 3.0 million tonnes with productivity of 901.7 kg ha^{-1}. Whereas in India, millets are being cultivated with an area of 1.88 million hectare producing 1.80 million tonnes with productivity of 1186 kg ha^{-1} (Anon., 2016).

Millets belongs to the most suitable crops for sustaining agriculture because they are grown under harsh conditions with negligible yield loses. Also, growing under low-input agricultural conditions and on the marginal lands are another advantages of this crop. In recent years, millet becomes important cereal for intercrop due to its wide adaptability to various agro-ecological conditions (Habiyaremye *et al.*, 2017).

They are highly nutritive and are having short duration, to make better utilization of resources and space suited for intercropping systems. Although these minor millet is a very important millets in Karnataka and also in Northern Transitional Zone. Hence there is need to assess the growth and profitability soybean and millets in intercropping systems.

Materials And Methods

The field experiment was conducted at Agricultural Research Station (ARS), Bailhongal, during *kharif* 2016 which is situated in Northern Transitional Zone of Karnataka and located between 15^{0}81' North latitude and 74^{0}86' East longitudes with an altitude of 546 m above MSL. The experiment was laid out in Randomized Block Design with three replications. Treatment details such as., T_1 - Soybean + foxtail millet (2:1), T_2 - Soybean + foxtail millet (4:2) , T_3 - Soybean + finger millet (2:1), T_4 - Soybean + finger millet (4:2) , T_5 - Soybean + little millet (2:1), T_6 - Soybean + little millet (4:2), T_7 - Sole crop of soybean, T_8 - Sole crop of foxtail millet, T_9 - Sole crop of finger millet and T_{10} - Sole crop of little millet. The observation on total dry matter production and economics of soybean and different millets. The data collected from the experiment were analyzed statistically following the procedure as described by Gomez and Gomez (1984). The level of significance used in 'F' test was P = 0.05. Critical difference values were calculated wherever the F test was significant.

Results and discussion

Total dry matter production in soybean

The results are presented in Table 1. At 30 DAS, significantly higher total dry matter plant^{-1} was recorded in sole soybean (3.07 g) compared to any intercropping systems. Among the intercropping systems, higher total dry matter plant^{-1} of soybean was recorded in 4:2 row ratio of soybean + finger millet (2.57 g). It was on par with 4:2 row ratio of soybean + foxtail millet (2.43 g) and 4:2 row ratio of soybean + little millet (2.17 g). Significantly lower total dry matter plant^{-1} was recorded in 2:1 row ratio of soybean + little millet (2.07 g). At 60 DAS, significantly higher total dry matter plant^{-1} was recorded in sole soybean (10.63 g) compared to any intercropping systems. Among the intercropping systems, higher total dry matter plant^{-1} of soybean was recorded in 4:2 row ratio of soybean + millets intercropping with foxtail millet (9.5 g). It was on par 4:2 row ratio of soybean + finger millet (9.09 g) and 4:2 row ratio of soybean + little millet (9.0 g). Significantly lower total dry matter plant^{-1} was recorded in intercropping of soybean + little millet in 2:1 row ratio

(8.87 g). A similar trend of total dry matter accumulation in 30 cm row length of millets was also recorded at 90 DAS. The similar results are reported by Sunilkumar *et al.* (2013).

Total dry matter production in millets

At 30 DAS, significantly higher total dry matter accumulation of millets was recorded in sole crop of foxtail millet (9.09 g) compared to their yield in intercropping systems. It was on par with 4:2 row ratio of soybean + foxtail millet (8.50 g) and 2:1 row ratio of foxtail millet (7.91 g). Significantly lower total dry matter plant^{-1} was recorded in intercropping of soybean + little millet in 4:2 row ratio (1.75 g). Higher dry matter production which might be due to efficient utilization of available resource which ultimately higher dry matter production. A similar trend of total dry matter accumulation in 30 cm row length of millets was also recorded at 60, 90 DAS and at harvest. The similar results are reported by Sunilkumar *et al.* (2013).

Economics

Among the sole crops, significantly higher gross and net returns were recorded in sole soybean (`Rs. 78,585 ha$^{-1}$ and `Rs. 68,457 ha^{-1} respectively) compared to millets due to higher market price (`Rs. 2,900 q$^{-1}$) and yield. Significantly lower gross and net returns were recorded in sole little millet (`Rs 37,931 ha^{-1} and ` Rs 20,783 ha$^{-1}$ respectively). The prevailing lower market price (foxtail millet- Rs ` 2200 q^{-1}, finger millet- Rs ` 2200 q$^{-1}$ and little millet- ` Rs 2100 q^{-1} respectively) coupled with lower yield per hectare resulted in lower economic returns in sole millet cropping. On the contrary, significantly higher B-C ratio was recorded in sole foxtail millet (1.73) compared to other sole crops due to lower cost of production. Among the intercropping systems, significantly higher gross and net returns was recorded in 4:2 row ratio of soybean + foxtail millet (Rs.` 96,403 ha$^{-1}$ and ` Rs. 68,457 ha^{-1} respectively) and it was on par with 2:1 row ratios of soybean + foxtail millet (Rs ` 94,724 ha$^{-1}$ and ` Rs. 66,779 ha^{-1} respectively). The lowest gross and net returns was recorded in 2:1 row ratio of soybean + little millet (`Rs. 82,199 ha$^{-1}$ and ` Rs. 54,115 ha^{-1} respectively). The increased gross and net returns in intercropping systems was mainly due to higher soybean and millet yield and higher market price of soybean. The similar results were reported by Shilpa (2016) at Dharwad, reported that, highest gross returns (Rs ` 45,519 ha$^{-1}$), net returns (Rs ` 21,730 ha^{-1}) and B: C ratio (1.91) was recorded in sweet sorghum + horsegram (2:1) compared to sole crops.

Table 1: Total dry matter accumulation in soybean as influenced by millet intercropping systems at different crop growth stages

Cropping system	Total dry matter plant^{-1} (g)								
	30 DAS			60 DAS			90 DAS		
	2:1	4:2	Mean	2:1	4:2	Mean	2:1	4:2	Mean
Soybean + foxtail millet	2.27	2.43	2.35	9.23	9.50	9.37	16.17	17.00	16.58
Soybean + finger millet	2.43	2.57	2.50	9.00	9.09	9.05	15.40	15.03	15.22
Soybean + little millet	2.07	2.17	2.12	8.87	9.00	8.93	14.40	15.00	14.70
Sole soybean	-	-	3.07	-	-	10.63	-	-	18.63
S.Em. ±	0.09			0.29			0.45		
C.D. at 5 %	0.27			0.86			1.33		

Table 2: Total dry matter accumulation in millets at 30, 60, 90 DAS and at harvest as influenced by soybean intercropping systems

Cropping system	Total dry matter accumulation (g) plant^{-1}											
	30 DAS			60 DAS			90 DAS			At harvest		
	2:1	4:2	Mean	2:1	4:2	Mean	2:1	4:2	Mean	2:1	4:2	Mean
Soybean + foxtail millet	7.91	8.50	8.21	18.20	18.90	18.55	24.01	24.66	24.34	28.93	29.47	29.20
Soybean + finger millet	5.80	6.22	6.01	16.20	16.50	16.35	20.87	21.42	21.15	24.94	25.98	25.46
Soybean + little millet	1.76	1.75	1.75	4.71	5.51	5.11	9.28	9.72	9.50	15.27	15.92	15.60
Sole foxtail millet	-	-	9.09	-	-	20.76	-	-	26.15	-	-	30.28
Sole finger millet	-	-	7.39	-	-	18.14	-	-	25.61	-	-	27.80
Sole little millet	-	-	1.78	-	-	6.69	-	-	12.19	-	-	16.72
S.Em. ±	0.25			0.51			0.50			0.73		
C.D. at 5 %	0.72			1.47			1.45			2.10		

Table 3: Economics of soybean based millets intercropping systems

Cropping system	Soybean seed equivalent yield (kg ha^{-1})	Gross returns (` ha^{-1})	Net returns (` ha^{-1})	B-C ratio
Soybean + foxtail millet (2:1)	2,310	94,724	66,779	2.39
Soybean + foxtail millet (4:2)	2,334	96,403	68,457	2.45
Soybean + finger millet (2:1)	2,116	87,054	58,433	2.01
Soybean + finger millet (4:2)	2,120	87,178	58,557	2.05
Soybean + little millet (2:1)	1,940	82,199	54,115	1.93
Soybean + little millet (4:2)	1,959	82,735	54,651	1.95
Sole soybean	2,255	78,585	49,558	1.71
Sole foxtail millet	1,901	48,690	30,824	1.73
Sole finger millet	1,805	46,558	26,951	1.37
Sole little millet	1,521	37,931	20,783	1.21
S.Em. ±	73.3	488.08	488.08	0.02
C.D. at 5 %	211.7	1409.67	1409.67	0.04

Note: Market price of the produce as per CACP-2017 (commission on agricultural costs and prices) Soybean - ` 2,900 q$^{-1}$, Foxtail millet - ` 2,200 q^{-1}, Finger millet - ` 2,200 q$^{-1}$ and Little millet - ` 2,100 q^{-1}

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