Madras Agric. J., 86(4-6): 260 - 263 April - June 1999
https://doi.org/10.29321/MAJ.10.A00595

INFLUENCE OF SEASON, ORGANIC MANURES, FERTILISERS AND WEED MANAGEMENT PRACTICES ON THE YIELD OF SOYBEAN

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ABSTRACT

Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore from 1994, covering two kharif and two summer seasons, to evaluate the influence of seasons on the yield of soybean. The yield increase in soybean during summer season was 8.7 per cent over kharif season. The agro-meteorological parameters computed indicated that Growing Degree Days (GDD) and Photothermal Unit (PTU) were comparatively higher for kharif seasons than summer season. However, Heliothermal Unit (HTU) and Heat Unit Efficiency (HUE) were higher for summer (1995 and 1996) as compared to the Kharif.

KEY WORDS: Soybean, Seasons, Agro-meteorological parameters Yield

Soybean is an important oilseed crop of India and it is cultivated in 3.0 million hectares with an annual production of 1.9 million tonnes. At Pantnagar, soybean crop produced higher yield in summer season than in Kharif (Singh *et al.*, 1973). However, few reports were in favour of Kharif soybean as compared to soybean raised during summer season (Veeramani, 1995). Hence to study the effect of seasons on the yield of soybean the present study was undertaken.

MATERIALS AND METHODS

Field experiments were conducted at Tamil Nadu Agricultural University,Coimbatore. The experimental site is located at 11 N latitude and 77 E longitude at an attitude of 426.7 m above mean sea level (MSL). The soil of the experimental field is deep clay loam in texture, classified under Typic haplustalf belonging to Noyyal series. The fertility status of the soil is classified as medium in available nitrogen (293 kg ha^{-1}) and high available potassium (598 kg ha^{-1}).

The soybean crop (variety CO 1) was raised at 30 x 10 cm spacing during the Kharif and summer of 1994-95 and 1995-96. The sowing and harvest period is given in Table 1.

Main Plot (Organic manures and fertilisers)

M_1 - FYM 12.5 t ha^{-1} + 20: 80 : 40 kg NPK ha^{-1}

M_2 - FYM 12.5 t ha^{-1} + 30: 120: 40 kg NPK ha^{-1}

M_3 - Sheep manure 6.5 t ha^{-1} + 20 : 80 : 40 kg NPK ha^{-1}

M_4 - Sheep manure 6.5 t ha^{-1} + 30 : 120 : 40 kg NPK ha^{-1}

M_5 - Bio-gas digested slurry 5.0 t ha^{-1} + 20 : 80 : 40 kg NPK^{-1}

M_6 - Bio-gas digested slurry 5.0 t ha^{-1} + 30 : 120 : 40 kg NPK^{-1}

Sub Plot (Weed management practices)

W_1 - Pendimethalin 0.75kg ha^{-1} + hand weeding (HW) at 40 days after sowing (DAS)

W_2 - Alachlor 1.0 kg ha^{-1} + HW AT 40 DAS

W_3 - Hand weeding twice on 20 and 40 DAS

W_4 - Unweeded control

All the manures were incorporated in the experimental plot as per the treatment schedule before sowing. Prilled urea (46 per cent N), single super phosphate (16 per cent P_2O_5) and muriate of potash (60 per cent K_2O) were used to supply N, P and K respectively. Half the dose of N and full dose of P and K were applied at the time of sowing.

Table 1. Sowing and harvest details

Season and year	Date of sowing	Date of harvest	Duration (days)
Kharif, 1994	6.6.94	8.9.94	94
Summer, 1995	4.1.95	5.4.95	91
Kharif, 1995	5.6.95	11.9.95	97
Summer, 1996	9.1.96	10.4.96	91

Remaining half the dose of the nitrogen was top pressed on 40 DAS after weeding operation. Two hand weedings were given on 20 DAS and 40 DAS for the treatments W_1 and W_2 one hand weeding was given on 40 DAS. No weeding was done for the treatment W_3. The herbicides viz. Pendimethalin at 0.75 kg ha^{-1} and alachlor at 1.0 kg ha^{-1} were sprayed as pre-emergence on 3 DAS as per the treatment schedule with a hand operated knapsack sprayer on 3 DAS as per the treatment schedule with a hand operated knapsack sprayer using a deflector type nozzle.

First irrigation was given immediately after sowing and life irrigation was given on 3 DAS. Subsequent irrigation were at the intervals of 7-10 and 10-15 days during summer and Kharif season respectively. Dimethoate 30EC spray was given at 500ml ha^{-1} to control white fly at 20 DAS. Endosulfan 35 EC was given at lit ha^{-1} to control the leaf feeding caterpillars at 40 DAS.

GDD or accumulated day degree is also called as "effective heat unit". This is an arithmetic accumulation of daily mean temperatures above certain threshold temperature. This was computed using the formula as suggested by Iwata (1984).

$$GDD = \frac{\text{Maximum temperature} + \text{Minimum temperature}}{2} - \text{base temperature}$$

Base temperature of 10°C for soybean was taken as reported by Chitra (1994) expressed in °C $season^{-1}$.

PTU for soybean was calculated four seasons. This was computed using the formula as suggested by Major *et al.* (1975) expressed in °C $season^{-1}$ hr.

PTU = GDD X mean day length (N)

The HTU was calculated by using the formula of Rajput (1980) expressed in °C $season^{-1}$ hr. HTU = GDD x Number of bright sunshine hours (n).

HUE or thermal time use efficiency is the amount of DMP or grain yield produced per unit of thermal time or growing degree days (Kiniry *et al.*, 1992). This was computed by using the following equation.

$$HUE = \frac{\text{Grain yield (kg ha}^{-1})}{\text{GDD (°C season}^{-1})}$$

expressed as kg ha^{-1} $°C^{-1}$ $season^{-1}$.

RESULTS AND DISCUSSION

Yield

The grain yield of soybean was higher during summer season (1560 to 2060 kg ha^{-1}) than kharif season (1381 to 1882 kg ha^{-1}) as evidenced from the pooled data in Table 2.

Table 2. Effect of organic manures, fertilisers and weed management practices on grain yield of soybean (kg ha^{-1}) (Pooled data)

Treatment	Kharif 1994 & '95					Summer 1995 & '96				
	W_1	W_2	W_3	W_4	Mean	W_1	W_2	W_3	W_4	Mean
M_1	1499	1595	1712	718	1381	1650	1828	1883	881	1560
M_2	1693	1807	1870	783	1538	1794	1994	2082	910	1695
M_3	1655	1716	1785	835	1498	1703	1904	1999	936	1636
M_4	1916	2031	2140	881	1742	2022	2240	2324	962	1887
M_5	1751	1893	1969	915	1632	1847	2075	2143	978	1761
M_6	2078	2236	2285	959	1890	2257	2459	2519	1005	2060
Mean	1765	1879	1960	848		1879	2083	2158	945	

	SE_D	CD (P=0.05)	SE_D	CD (P=0.05)
Manures (M)	27	60	29	64
Weed Control (W)	6	13	9	19
M at W	31	66	33	70
W at M	17	34	20	40

Table 3. Influence of agro - meteorological parameters on the performance of soybean

Std week	Date	Kharif 1994			Kharif 1995			Std Week	Date	Summer 1995			Summer 1996		
		GDD	PTU	HTU	GDD	PTU	HTU			GDD	PTU	HTU	GDD	PTU	HTU
23	Jun 4-10	116.6	1480.8	221.5	133.0	1689.1	1	Jan. 1-7	87.5	1015.0	490.0	101.9	1182.0	896.7	
24	11-17	120.4	1529.1	301.0	118.6	1506.2	640.4	2	8-14	110.6	1282.9	774.2	108.2	1255.1	757.4
25	18-24	127.8	1623.1	1086.3	122.9	1560.8	811.1	3	15-21	103.3	1198.3	599.1	94.5	1096.2	926.1
26	25-1	123.2	1564.6	381.9	123.2	1564.6	689.9	4	22-28	99.1	1149.5	842.4	97.0	1125.2	931.2
27	Jul. 2-8	115.9	1460.3	498.4	122.5	1543.5	833.0	5	29-4	108.5	1258.6	835.5	104.7	1214.5	879.5
28	9-15	110.6	1393.6	143.8	122.9	1548.5	417.9	6	Feb. 5-11	106.1	1251.9	944.3	114.1	1346.4	992.7
29	16-22	115.2	1451.5	414.7	115.9	1460.3	359.3	7	12-18	113.1	1334.6	1040.5	124.6	1445.4	1233.5
30	23-29	116.6	1469.2	174.9	115.5	1455.3	473.6	8	19-25	124.36	1466.7	1080.9	117.3	1360.7	1137.8
31	30-5	112.0	1388.8	313.6	130.6	1645.69	992.6	9	26-4	119.7	1412.5	442.9	110.3	1279.5	1279.5
32	Aug. 6-12	119.0	1475.6	725.9	120.4	1493.0	866.9	10	5-11	120.4	1444.8	1071.6	120.4	1444.8	1312.4
33	13-19	118.0	1463.2	460.2	81.6	1011.8	587.5	11	12-18	122.5	1470.0	1298.5	136.2	1634.4	1389.2
34	20-26	119.7	1484.3	335.2	124.6	1545.0	697.8	12	19-25	126.0	1512.0	1335.6	142.8	1713.6	1242.4
35	27-2	116.9	1449.6	374.1	113.4	1406.2	317.5	13	29-1	134.4	1612.8	1209.6	142.8	1713.6	1285.2
36	Sep. 3-9	120.1	1453.2	792.7	118.3	1431.4	828.1	14	Apr. 2-8	139.3	1713.4	1239.8	128.5	1542.0	835.3
37	10-16	-	-	-	119.4	1444.7	1038.8		-	-	-	-	-	-	-
Total		**1652**	**20686.9**	**6244.2**	**1782.8**	**22307**	**10605.1**	**Total**		**1614.8**	**19123**	**13204.9**	**1643.3**	**19353.4**	**15032.7**

HUE = 0.98 kg ha^{-1} °C^{-1} season^{-1}

HUE = 0.99 kg ha^{-1} °C^{-1} season^{-1}

HUE = 1.05 kg ha^{-1} °C^{-1} season^{-1}

HUE = 1.01 kg ha^{-1} °C^{-1} season^{-1}

Significant variation was observed on the yield of soybean in both the season due to combined application of organic manures and inorganic fertilisers. Conjunctive application of bio-digested slurry + 30 : 120 : 40 kg NPK ha^{-1} (M6) recorded the highest yield of 1882 and 2060 kg ha^{-1} during kharif and summer respectively. It was followed by the combined application of sheep manure + 30:120:40 kg NPK ha^{-1} (M4) which produced a yield of 1742 and 1887 kg ha^{-1} during kharif and summer respectively.

Weed management practices resulted in profound increase in the grain yield of soybean. Unweeded check (W4) registered the lowest yield of 848 and 945 kg ha^{-1} during kharif and summer season respectively. Hand weeding twice (W3) recorded the highest yield of 1960 and 2158 kg ha^{-1} during the respective seasons, which was markedly superior over alachor 1.0 kg ha^{-1} + one hand weeding (W2) and pendimethalin 0.75 kg ha^{-1} + and hand weeding (W1).

Interaction of organic manures and inorganic fertilisers with weed management practices on the yield of soybean was significant in both kharif and summer seasons. Bio-digested slurry + 30:120:40 kg NPK ha^{-1} with hand weeding twice (M_6W_3) proved to be the best combination for getting highest grain yield. It was followed by the application of bio-digested slurry + 30:120:40 kg NPK ha^{-1} with alachlor 1.0 kg ha^{-1} + one hand weeding (M_6W_2)

Influence of season on yield of soybean

The agro-meteorological parameters (GDD, HTU, PTU and HUE) computed for the four seasons of study are presented in Table 3.

The values of GDD and PTU were comparatively higher for kharif seasons than summer seasons. In respect of HTU the trend was reverse, wherein higher values were recorded for summer seasons than kharif season. The study on productivity weather index (HUE) indicated that it was higher for two summer (1995 and 1996) as compared to the two kharif seasons.

Weber (1968) from his experimentation concluded that soybean crop needed the least cloudy environment for good photosynthetic production. This was true for the present investigation also, wherein the HTU values (an indirect index of non-cloudiness) was higher for summer (13204.9 and 15032.7 during summer 95 and 96 respectively) as against kharif season (6224.2 and 10605.1 during kharif 94 and 95 respectively). This promoted the growth of soybean to a greater extent. In other way the temperature and non-cloudiness had a greater role on the productivity of soybean than GDD alone or PTU alone. Egli (1980) reported that the ideal temperature for soybean growth ranged from 22 to 33°C. This range of temperature and least cloudiness prevailed during summer seasons favoured the growth characters and yield attributes. Effective translocation of photosynthates might have happened as a result. This could be proved through the HUE parameter, wherein the utilization of temperature for grain production was greater for both summer '95 and '96 compared to kharif '94 and '95 seasons.

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(Received : April 1998 Revised : August 1999).