Integrated weed management in soybean (*Glycine max* (L) *Merrill*), under various plant densities

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Abstract : A study was undertaken at Agricultural College & Research Institute, Coimbatore during Summer and Kharif seasons of 1994 to investigate the effect of three levels of plant densities with various weed management methods in Soybean. The results revealed that the weed density significantly reduced in the higher plant density of 6.66 lakh plants ha^{-1} in both the seasons. Among the weed management methods, pre-emergence application of alachlor 1.25 kg ha^{-1} + hand weeding (40 DAS) and hand weeding twice (20 and 40 DAS after sowing) have considerably reduced the weed population and enhanced the grain yield. However, hand weeding twice had exhibited similar effect as that of alachlor 1.25 kg ha^{-1} + hand weeding (40 DAS) in suppressing the weed population at 40 DAS. The yield attributes like number of pods per plant, number of seeds per pod and test weight of the seeds were greatly influenced at lowest plant density of 3.33 lakh plants ha^{-1}, however it was comparable with 4.44 lakh plants ha^{-1} in registering the test weight. There was significant increase in yield of the crop under 4.44 lakh plants ha^{-1}. (*Key Words : Weed management, Plant density, Weed population and Yield attributes*).

Soybean is an important oil yielding crop of Tamil Nadu. In soybean initial slow growth provides congenial environment for weed growth. Weeds compete with soybean for moisture, light and nutrients and reduce the yield to the tune of 17 percent. Though manual weeding is the normal practice, non-availability of labour at critical periods of crop weed competition results in delayed weeding and reduces the grain yields. Under the present situation of labour scarcity for agricultural, weed management has to be practiced through an integrated approach using manual, chemical and biological methods.

Almost in all the crops, plant density plays an important role in suppressing the weed growth. Soybean forms a dense canopy of leaves after its initial slow growth which also less light penetration to the soil surface and more competitive to emerging weeds. McWhorter and Hartwig (1972), reported that weed control was effective when soybean grown in rows closer together. Keeping above in view, the present investigation was taken up to develop an optimum plant geometry and weed control method in soybean.

Materials and Methods

An experiment was conducted at the Agricultural College and Research Institute, Coimbatore during Summer and Kharif seasons of 1994. The soil of the experimental field was deep, well drained sandy clay loam with low, medium and high available nitrogen, phosphorus and potassium respectively. Soybean Co-1 with a duration of 85 days was used in this study. Three plant densities *viz.*, 3.33, 4.44 and 6.66 lakh plants with spacement of 30x10cm, 30x7.5 cm and 30x5.0 cm respectively, were allotted randomly in main plots. Weed management methods like unweeded control, hand weeding at 20 and 40 days after sowing, pre emergence herbicides *viz.*, Pendimethalin 0.75 kg ha^{-1} + hand weeding (40 DAS), alachlor 1.25 kg ha^{-1} + hand weeding (40 DAS) and oxyflourfen 0.20 kg ha^{-1} + hand weeding (40 DAS) were imposed randomly in subplots. Data on weed density per square metre and weed dry matter production were recorded on 20, 40, 60 DAS and at harvest. Data on various biometric observation of the crop were recorded and statistically analysed and discussed below.

Results and Discussion

The weed population was considerably reduced by higher plant density of 6.66 lakh plants ha^{-1} at all stages which indicated the suppressing effect of soybean with high plant density on weed (Table 1) as observed by Arumugam (1994). All the weed management treatments markedly reduced the total weed population as compared to unweeded control throughout the crop period in both the seasons. In the early stage (20 DAS) of the crop, alachlor 1.25 kg ha^{-1} + hand weeding (40 DAS) controlled the weeds effectively followed by oxyflourfen 0.20 kg ha^{-1} + hand weeding (40 DAS). As the crop period advances the applied herbicides may become less effective which favours the regen-

Table 1. Effect of plant density and weed management methods on weed population (No.m^{-2})

Treatment	Summer 1994				Kharif 1994			
	20 DAS	40 DAS	60 DAS	At harvest	20 DAS	40 DAS	60 DAS	At harvest
Plant Densities								
3.33 lakh ha^{-1}	56.1 (1.61)	50.9 (1.64)	44.4 (1.36	37.2 (1.32)	58.3 (1.63)	53.3 (1.66)	47.1 (1.37)	41.0 (1.35)
44.4 lakh ha^{-1}	50.4 (1.57)	45.6 (1.56)	40.0 (1.32)	33.3 (1.25)	52.9 (1.59)	47.1 (1.58)	42.2 (1.32)	36.4 (1.26)
6.66 lakh ha^{-1}	38.4 (1.44)	34.5 (1.44)	30.8 (1.16)	25.5 (1.14)	41.2 (1.47)	35.8 (1.46)	33.1 (1.16)	27.6 (1.16)
SE$_d$	0.05	0.05	0.03	0.05	0.04	0.05	0.03	0.06
CD (P=0.05)	0.12	0.11	0.06	0.12	0.10	0.12	0.06	0.14
Weed Management								
Unweeded control	91.7 (1.95)	106.1 (2.03)	142.1 (2.12)	117.5 (2.05)	94.3 (2.01)	110.1 (2.10)	145.5 (2.14)	128.5 (2.07)
HW (20 & 40 DAS)	88.8 (1.93)	15.5 (1.19)	3.9 (0.73)	4.4 (0.78)	91.1 (1.96)	19.8 (1.22)	4.8 (0.77)	5.1 (0.79)
Pendimethalin 0.75 kg ha^{-1} + HW (40 DAS)	35.4 (1.55)	41.8 (1.62)	20.9 (1.34)	17.1 (1.23)	37.7 (1.58)	44.0 (1.64)	23.2 (1.35)	18.8 (1.31)
Alachlor 1.25 kg ha^{-1} + HW (40 DAS)	11.2 (1.06)	23.3 (1.37)	9.7 (1.03)	7.7 (0.95)	12.3 (1.12)	25.5 (1.39)	10.5 (1.03)	8.4 (1.00)
Oxyflourfen 0.20 kg ha^{-1} + (40 DAS)	16.6 (1.24)	32.4 (1.50)	15.5 (1.22)	13.3 (1.15)	18.2 (1.26)	35.4 (1.51)	17.8 (1.25)	14.6 (1.19)
SE$_d$	0.103	0.059	0.036	0.04	0.099	0.124	0.035	0.061
CD(P=0.05)	0.207	0.118	0.072	0.08	0.199	0.249	0.070	0.121

Figures in the parentheses are log (x+2) transformed values.

DAS : Days After Sowing, HW : Hand Weeding.

Table 2. Effect of plant densities and weed management methods on yield attributes of soybean

Treatments	Summer 1994			Kharif 1994		
	No.of Pods plant⁻¹	No.of seeds pod⁻¹	100 Grain weight (g)	No.of Pods plant⁻¹	No.of seeds pod⁻¹	100 Grain weight (g)
Plant densities						
3.33 lakh ha⁻¹	37.6	2.4	9.1	39.9	2.5	9.2
44.4 lakh ha	34.9	2.8	9.1	37.2	2.4	9.1
6.66 lakh ha	28.8	2.2	9.0	31.8	2.2	9.0
SEd	0.43	0.03	0.04	0.57	0.03	0.005
CD (P=0.05)	0.95	0.06	0.08	1.26	0.06	0.01
Weed Management						
Unweeded control	24.5	2.2	8.8	27.4	2.2	8.8
HW (20 & 40 DAS)	37.4	2.4	9.1	40.5	2.4	9.1
Pendimethalin 0.75 kg ha⁻¹ + HW (40 DAS)	34.1	2.3	9.1	35.7	2.4	9.1
Alachlor 1.25 kg ha⁻¹ + HW (40 DAS)	38.3	2.4	9.1	41.6	2.5	9.1
Oxyflourfen 0.20 kg ha⁻¹ + (40 DAS)	34.4	2.3	9.1	36.3	2.5	9.1
SEd	1.17	0.05	0.02	1.71	0.06	0.025
CD (P=0.05)	2.35	0.10	0.02	3.34	0.12	0.05

DAS-Days After Sowing ; HW – Hand Weeding

Table 3. Interaction effect of plant densities and weed management methods on weed population, and yield of soybean (Summer 1994).

Treatment	Weed population (No.m⁻² at 40 DAS)				Grain yield (kg ha⁻¹)			
	D_1	D_2	D_3	Mean	D_1	D_2	D_3	Mean
Unweeded control	120.8 (2.15)	109.7 (2.03)	86.0 (1.93)	105.5 (2.03)	1306	1680	1426	1465
Hand Weeding (20 & 40 DAS)	17.3 (1.27)	15.3 (1.21)	11.7 (1.11)	14.8 (1.20)	2208	2442	2238	2296
Pendimethalin 0.75 kg ha⁻¹ + HW (40 DAS)	47.3 (1.66)	43.7 (1.64)	34.3 (1.54)	41.8 (1.62)	1966	2190	2014	2056
Alachlor 1.25 kg ha⁻¹ + HW (40 DAS)	29.3 (1.48)	24.8 (1.41)	17.0 (1.23)	23.7 (1.37)	2241	2455	2277	2324
Oxyflourfen 0.20 kg ha⁻¹ + HW (40 DAS)	39.8 (1.60)	34.3 (1.54)	23.3 (1.36)	32.5 (1.50)	2072	2284	2120	2158
Mean	50.9 (1.64)	45.6 (1.56)	34.5 (1.44)		1955	2188	2037	
	D	W	W at D	D at W	D	W	W at D	D at W
SE$_d$	0.049	0.059	0.110	0.091	65.4	43.4	151.5	172.3
CD (P=0.05)	0.109	0.118	0.220	0.183	145.71	87.29	NS	NS

D_1: 3.33 lakh plants ha⁻¹
D_2: 4.44 lakh plants ha⁻¹
D_3: 6.66 lakh plants ha⁻¹
DAS: Days After Sowing
HW: Hand Weeding

cration of weeds 40 DAS. At later stages (60 DAS and at harves), hand weeding twice (20 and 40 DAS) was found to be best followed by alachlor 1.25 kg ha⁻¹ + hand weeding (40 DAS) any oxyflourfen 0.20 kg ha + hand weeding (40 DAS) (Table-1). Singh and Sharma, (1991) reported the efficacy of alachlor either alone (or) in combination with hand weeding in controlling the broad spectrum of weeds. Likewise the efficacy of oxyflourfen as pre-emergence spray was reported by Maurya et al. (1990).

Interaction effects between plant densities and weed management methods were observed in checking the weed population, at 40 DAS. Meanwhile, hand weeding on 20 and 40 DAS with the higher plant density of 6.66 lakh plants ha⁻¹ markedly reduced the weed population at 40 DAS during both the seasons. Similar effect was also observed in alachlor 1.25 kg ha⁻¹ + hand weeding (40 DAS) followed by oxyflourfen 0.20 kg ha⁻¹ + hand weeding (40 DAS) under the plant density of 6.66 lakh plants ha⁻¹ during both the seasons (Table 3,4). However, all the weed management methods with 4.44 lakh plants ha⁻¹ were comparable to that of 6.66 lakh plants ha⁻¹ during both the seasons. The results revealed that the number of pods per plant decreased with increase in plant density. The number of pods per plant were 37.6, 34.8, and 28.8 respectively (Table 2). The increase in plant density decreased the number of pods per plant due to the competition between plants. Similar observations were made by Kadlec and Letal (1992) in soybean. But the total number of pods per unit area (per m²) increased with decrease in plant density as reported by Ganesa Raja (1990). The seed number per pod and the test weight were decreased with increase in plant population (6.66lakh plants ha⁻¹). It clearly indicated that low plant densities of 3.33 lakh plants ha⁻¹ and 4.44 lakh plants ha⁻¹ were found optimum for higher productivity (Table 2). Which is in agreement with the findings of Arumugam (1994). The reason attributed for such

Table 4. Interaction effect of plant densities and weed management methods on weed population, and yield of soybean. (*Kharif* 1994).

Treatment	Weed population (No.m⁻² at 40 DAS)				Grain yield (kg ha⁻¹)			
	D_1	D_2	D_3	Mean	D_1	D_2	D_3	Mean
Unweeded control	116.5 (2.17)	108.3 (2.09)	83.0 (1.96)	102.6 (2.08)	1470	1627	1579	1558
Hand Weeding (20 & 40 DAS)	24.4 (1.31)	19.1 (1.24)	14.9 (1.11)	19.8 (1.22)	2360	2549	2545	2486
Pendimethalin 0.75 kg ha⁻¹ + HW (40 DAS)	51.9 (1.73)	45.6 (1.65)	34.4 (1.52)	44.0 (1.63)	2067	2270	2259	2192
Alachlor 1.25 kg ha⁻¹ + HW (40 DAS)	30.5 (1.48)	25.2 (1.41)	20.9 (1.28)	25.5 (1.39)	2362	2565	2552	2506
Oxyflourfen 0.20 kg ha⁻¹ + HW (40 DAS)	43.3 (1.60)	37.1 (1.53)	25.8 (1.40)	35.4 (1.51)	2116	2278	2269	2227
Mean	53.3 (1.66)	47.1 (1.58)	35.8 (1.46)		2078	2258	2241	
	D	W	W at D	D at W	D	W	W at D	D at W
SEd	0.049	0.059	0.110	0.091	65.4	43.4	151.5	172.3
CD (P=0.05)	0.109	0.118	0.220	0.183	145.71	87.29	NS	NS

D_1:3.33 lakh plants ha⁻¹ D_2: 4.44 lakh plants ha⁻¹ D_3:6.66 lakh plants ha⁻¹

DAS: Days After Sowing   HW : Hand Weeding

a result might be due to competition of soybean under higher density.

Among the weed management methods, the number of pods per plant were more under alachlor 1.25 kg ha⁻¹ + hand weeding (40 DAS) but was comparable with hand weeding twice. This might be due to effective control of weeds in these treatments. Similar results was reported by Borgohain and Dhua (1987). The next best treatment was oxyflourfen 0.20 kg ha⁻¹ + hand weeding (40 DAS). Which was on par with pendimethalin 0.75 kg ha⁻¹ + hand weeding (40 DAS). Unweeded control recorded markedly lesser number of pods per plant. Severe weed competition in unweeded control as well as pendimethalin 0.75 kg ha⁻¹ + hand weeding w(40 DAS) might have reduced number of pods per plant (Table 2). The number and test weight of seeds were higher in all the treatments except unweeded control (Table 2). Severe weed competition and reduction in seeds due to unchecked weed growth were also observed by Nalayini (1990).

The yield of soybean (2188 and 2258 kg ha⁻¹ in summer and kharif respectively) was found to be higher with 4.44 lakh plants ha⁻¹. Among the weed management treatments, alachlor 1.25 kg ha⁻¹ + hand weeding (40 DAS), hand weeding twice (20 and 40 DAS), and oxyflourfen 0.20 kg ha⁻¹ + hand weeding (40 DAS) registered higher yields (58.6, 56.7 and 47.3 percent in kharif over unweeded check) (Table 3, & 4). This might be due to effective control of weeds. Pre emergence herbicides were effective, only in early stages. If one hand weeding was supplemented with those herbicides on 40 DAS the weeds could be effectively controlled up to 60 DAS. Several workers like Singh and Sharma (1991) confirmed this.

The study proved that pre-emergence application of alachlor 1.25 kg ha⁻¹ with hand weeding on 40 days after sowing with a plant density of 4.44 lakh plants ha⁻¹ is the most effective integrated weed management method for obtaining higher productivity in soybean.

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