Effect of Weed Management on Weeds, Nutrient Uptake, Nodulation, Growth and Yield of Summer Mungbean (*Vigna radiata*)

Gaganpreet Kaur, H. S. Brar and Guriqbal Singh[1]
Department of Agronomy
Punjab Agricultural University, Ludhiana-141 004 (Punjab), India

Mungbean [*Vigna radiata* (L.) Wilczek], also known as greengram, is the third most widely cultivated pulse crop in India. Pulse crops have been the mainstay of Indian agriculture for providing protein-rich diet to vegetarian masses of the country. Being leguminous crops they have beneficial effect on improving soil fertility through fixation of atmospheric nitrogen. Summer mungbean often suffers from severe crop-weed competition because it is grown under irrigated conditions. Infestation of weeds is a major constraint in achieving higher yield of summer mungbean (Singh and Sekhon, 2002), as these compete with crop plants for nutrients, moisture, light and space. The magnitude of reduction in yield depends upon the weed flora present, quantum of weed flora and duration of crop-weed competition. Critical period for crop-weed competition in summer mungbean is from 15 to 30 days after sowing (Singh *et al.*, 1996). Thus, it is imperative to eliminate weeds from the crop at proper time and with suitable methods. Though weeds can be controlled by hoeing yet due to shortage of labour it becomes difficult to do hoeing at appropriate time and delayed hoeing may cause economic loss.

A field experiment was conducted at the Punjab Agricultural University, Ludhiana, India during summer 2003 to study the effect of weed control in summer mungbean. Ludhiana (Latitude 30° 56′ N, longitude 75° 52′ E, altitude 247 m above the sea level) is located in the sub-tropical region. The soil of the experimental field was loamy sand in texture, having pH 8.2, low in organic carbon (0.33%), low in available nitrogen and medium in available phosphorus and potassium content.

Twelve treatments viz., unweeded check, one and two hoeings [25 and 45 days after sowing (DAS)], two hoeings with wheel hoe (25 and 40 DAS), fluchloralin 0.625 kg/ha, trifluralin 0.96 kg/ha, pendimethalin 0.45 and 0.75 kg/ha, quizalofop-ethyl 35 and 50 g/ha and chlorimuron-ethyl 9 and 15 g/ha were tested in a randomized complete block design with four replications and net plot size was 4.5 x 2.025 m. The crop was sown on 28 March, 2003 in row spacing of 22.5 cm using a recommended seed rate of 37.5 kg/ha of variety SML 668. The pre-plant incorporation of fluchloralin and trifluralin and pre-emergence application of pendimethalin was done on the same day at the time of sowing and after sowing of the crop, respectively. The post-emergence application of quizalofop and chlorimuron was done 20 DAS using knapsack sprayer fitted with a flat-fan nozzle. Two hand hoeings were done at 25 and 40 days after sowing using khurpa (a small hand operated tool) and wheel hoe in respective treatments. Four irrigations were given to the crop : 1st on 13th April, 2nd on 23rd April, 3rd on 2nd May and 4th on 28th May. Data on weed count and weed dry matter were recorded 25 and 40 DAS and at harvest, using a quadrat measuring 50 x 50 cm. Data on nodulation and plant growth were recorded 25 DAS and data on yield and yield attributes were recorded at harvest. Weed as well as plant samples were analyzed for nutrient (nitrogen, phosphorus and potassium) uptake at harvest. The data were analyzed and treatments having a significant F value, critical difference (CD) values were calculated at 5% probability level.

Weed Count

Cyperus spp. were the predominant weed in the experimental field (Table 1). These were not controlled very effectively by any of the herbicides and maximum intensity was observed in case of unweeded check, whereas low intensity was in hand hoeing twice at 25 and 40 DAS as well as in chlorimuron treatments. It was reported earlier also that *Cyperus* spp. were not controlled effectively by the pre-emergence application of pendimethalin and pre-plant incorporation of fluchloralin or trifluralin (Singh *et al.*, 1999; Kumar and Kundra, 2001).

Trianthema portulacastrum and *Eragrostis*

[1]Department of Plant Breeding and Genetics.

Table 1. Weed counts/m^2 under different treatments at various crop stages

Treatments	Growth stages (DAS)	*Cypersus* spp.	*Trianthema portulacastrum*	*Eragrostis tenella*	Total*
Unweeded control	25	28	9	1	40
	40	28	11	10	49
	At harvest	30	14	18	69
One hand hoeing (25 DAS)	25	18	6	8	32
	40	20	1	2	25
	At harvest	11	2	3	17
Two hand hoeings	25	11	8	4	23
(25 & 40 DAS)	40	18	2	2	22
	At harvest	13	4	1	21
Two hoeings with wheel hoe	25	20	7	1	28
(25 & 40 DAS)	40	20	2	1	24
	At harvest	2	3	0	9
Fluchloralin 0.625 kg/ha	25	11	5	0	18
	40	21	4	0	26
	At harvest	12	3	1	16
Trifluralin 0.96 kg/ha	25	18	2	0	22
	40	17	1	0	20
	At harvest	14	2	0	17
Pendimethalin 0.45 kg/ha	25	19	0	0	20
	40	12	1	3	17
	At harvest	13	2	0	15
Pendimethalin 0.75 kg/ha	25	12	0	0	12
	40	11	0	0	11
	At harvest	8	1	0	9
Quizalofop-ethyl 35 g/ha	25	6	4	2	14
	40	10	10	5	29
	At harvest	4	6	6	18
Quizalofop-ethyl 50 g/ha	25	19	5	3	29
	40	20	4	3	30
	At harvest	13	2	3	21
Chlorimuron-ethyl 9 g/ha	25	11	8	2	24
	40	9	8	13	37
	At harvest	10	4	12	31
Chlorimuron-ethyl 15 g/ha	25	10	8	12	31
	40	5	5	9	23
	At harvest	3	2	12	20

*Includes some other weeds also.

tenella were the other prominent weeds. Intensity of these weeds was the maximum in unweeded check. Their intensity increased upto the crop harvest stage. *T. portulacastrum* was effectively controlled by hoeing, pre-emergence application of trifluralin 0.96 kg/ha or by both the doses of pendimethalin i. e. 0.45 and 0.75 kg/ha. Pre-plant application of fluchloralin at 0.625 kg/ha also showed good control of *T. portulacastrum*, while the other herbicides had little effect. Balyan *et al.* (1995) also observed that pre-plant incorporation of trifluralin at 1.5 kg/ha was the most effective in minimizing the density of *T. portulacastrum. E. tenella* was effectively controlled by mechanical treatments like two hand hoeings or two hoeings with wheel hoe both at 25 and 40 DAS or by herbicides, namely, fluchloralin 0.625 kg/ha, trifluralin 0.96 kg/ha and pendimethalin 0.45 and 0.75 kg/ha. The post-emergence application of chlorimuron-ethyl failed to control *T. portulacastrum* and *E. tenella.*

In some treatments, reduction in the number of weeds was observed after 40 days. This was possible due to the smothering effect of the crop. Such an effect has also been reported by many workers (Singh *et al.*,

1996) in mungbean. Total weed population decreased with mechanical as well as chemical treatments. However, among the herbicides pendimethalin was the most effective. Nayak *et al.* (2000) also reported that total weed population decreased with pendimethalin 1.25 kg/ha.

Dry Matter of Weeds

The highest dry matter of weeds was observed in unweeded check, especially at 40 DAS and at harvest stage (Table 2). At 25 DAS, pendimethalin, fluchloralin and trifluralin treatments had significantly lesser amounts of weeds than the other treatments. At 40 DAS, hoeing and herbicide treatments had significantly less dry matter of weeds. The higher dose of pendimethalin was more effective in controlling weeds than the lower dose. At harvest, all the treatments recorded significantly less dry matter production of weeds than the unweeded control. Two hoeings, 25 and 40 DAS and pendimethalin 0.75 kg/ha showed least amount of dry matter of weeds but were at par with trifluralin 0.96 kg/ha. Kundra *et al.* (1989) recorded high weed control efficiency in two hoeings at 3 and 5 weeks after sowing. They also reported that pendimethalin at 0.5 and 0.75 kg/ha resulted in significant reduction in dry matter of weeds over the unweeded check. In another experiment, Nayak *et al.* (2000) also observed that weed dry matter was low in two hand hoeings and pendimethalin 1.25 kg/ha.

Nutrient Removal by Weeds

The maximum nutrient removal by weeds was observed in unweeded control i. e. 68.90, 19.29 and 77.17 kg/ha of N, P and K, respectively (Table 3). Nutrient uptake by weeds was minimum in case of pendimethalin 0.75 kg/ha i. e. 8.70, 3.17 and 11.57 kg/ha of N, P and K, respectively. It was followed by pendimethalin 0.45 kg/ha. Though N and P removal was lower in chlorimuron 15 g/ha than pendimethalin 0.45 kg/ha yet it was due to phytotoxic effect of herbicide on both crop and weeds, whereas in pendimethalin 0.45 kg/ha it was due to control of weeds only. These results are in line with those of Kundra *et al.* (1991) who reported the highest nutrient uptake by weeds in unweeded check i. e. 79.1, 19.8 and 79.1 kg/ha nitrogen, phosphorus and potassium, respectively, and nutrient removal was low in case of fluchloralin 0.75 kg/ha and pendimethalin 0.5 and 0.75 kg/ha. Velu (1995) observed very low uptake of nutrients by weeds where hand hoeing was done as compared to unweeded check.

Table 2. Dry matter of weeds as influenced by different treatments

Treatments	Dry matter of weeds (q/ha)		
	25 DAS	40 DAS	At harvest
Unweeded control	0.93	1.67	27.56
One hand hoeing (25 DAS)	0.97	0.71	8.56
Two hand hoeings (25 & 40 DAS)	0.94	0.69	5.07
Two hoeings with wheel hoe (25 & 40 DAS)	0.94	0.84	9.46
Fluchloralin 0.625 kg/ha	0.11	0.60	10.47
Trifluralin 0.96 kg/ha	0.12	0.65	7.80
Pendimethalin 0.45 kg/ha	0.08	0.59	8.27
Pendimethalin 0.75 kg/ha	0.06	0.48	4.63
Quizalofop-ethyl 35 g/ha	0.96	0.36	12.83
Quizalofop-ethyl 50 g/ha	0.92	0.31	15.67
Chlorimuron-ethyl 9 g/ha	0.96	0.39	18.29
Chlorimuron-ethyl 15 g/ha	0.97	0.32	9.67
LSD (P=0.05)	0.09	0.09	3.95

Nutrient Uptake by the Crop

Two hoeings at 25 and 40 DAS removed the highest amount of nitrogen i. e. 107.78 kg/ha, followed by two hoeings with wheel hoe at 25 and 40 DAS and pendimethalin 0.75 kg/ha (Table 3). Nitrogen uptake by the crop was lower in unweeded check than all other treatments except in post-emergence herbicides i. e. quizalofop at 35 and 50 g/ha and chlorimuron at 9 and 15 g/ha. Similarly, phosphorus removal by the crop was the highest in two hoeings with wheel hoe at 25 and 40 DAS followed by fluchloralin 0.625 kg/ha, two hand

Table 3. Uptake of N, P and K by the crop and weeds as influenced by different treatments

Treatments	Nutrient uptake (kg/ha)					
	Weeds			Crop		
	N	P	K	N	P	K
Unweeded control	68.90	19.29	77.17	60.66	14.96	51.30
One hand hoeing (25 DAS)	26.26	8.59	20.54	94.18	20.64	67.86
Two hand hoeings (25 & 40 DAS)	17.75	6.90	13.69	107.78	25.10	75.50
Two hoeings with wheel hoe (25 & 40 DAS)	16.27	6.62	13.65	104.25	26.74	80.40
Fluchloralin 0.625 kg/ha	18.65	6.77	16.98	94.96	25.15	78.35
Trifluralin 0.96 kg/ha	22.38	9.46	16.38	89.33	22.12	72.56
Pendimethalin 0.45 kg/ha	12.23	4.50	17.19	92.99	21.45	69.97
Pendimethalin 0.75 kg/ha	8.70	3.17	11.57	101.0	23.51	82.71
Quizalofop-ethyl 35 g/ha	35.66	12.39	34.50	53.25	16.99	53.37
Quizalofop-ethyl 50 g/ha	30.18	9.27	29.77	38.96	15.16	59.84
Chlorimuron-ethyl 9 g/ha	17.18	7.86	22.92	9.12	3.24	8.58
Chlorimuron-ethyl 15 g/ha	9.01	4.16	19.34	16.30	3.67	11.98

hoeings at 25 and 40 DAS and pendimethalin 0.75 kg/ha. However, it was lower in unweeded check (14.96 kg/ha) than all other treatments except chlorimuron. High potassium uptake (82.71 kg/ha) was in pendimethalin 0.75 kg/ha, followed by two hoeings with wheel hoe at 25 and 40 DAS and fluchloralin 0.625 kg/ha. However, very low uptake was in unweeded check. The studies conducted by Velu (1995) also showed that nutrient uptake by the crop was very low in unweeded check as compared to the efficient weed control treatments. Higher amounts of nutrient uptake by the crop in case of PPI and PRE herbicides were due to better plant growth and higher straw as well as grain yields. Conversely, in case of unweeded control and post-emergence herbicides lower amounts of nutrient uptake by the crop were due to poor plant growth and lower yields.

Effect on Crop Growth and Nodulation

Plant height indicates the weed suppressing ability of a crop. At 25 DAS, the highest plant height was shown by pendimethalin 0.45 kg/ha. However, the shortest plant height was observed in chlorimuron at both the doses due to its phytotoxic effect on the crop. Application of fluchloralin, trifluralin and pendimethalin showed higher dry matter than the other treatments. However, post-emergence herbicides showed significantly less dry matter accumulation. Chlorimuron gave very low dry matter per plant at both the doses due to its phytotoxic effect on crop.

In pendimethalin and fluchloralin treatments, nodules per plant were numerically higher than the other treatments (Table 4). The data indicate that both pendimethalin and fluchloralin had no adverse effect on the number of nodules. Trifluralin showed the minimum number of nodules. Two hoeings 25 and 40 DAS, fluchloralin and unweeded control had significantly more nodule dry weight than the other treatments. The treatments of pendimethalin had less dry weight of nodules indicating that the size of nodules was influenced by its application. Chlorimuron 15 g/ha had adverse effect on the dry weight of nodules. Pahwa and Prakash (1996) observed higher number of nodules per plant in mungbean with the use of herbicides as compared to control (no herbicide application) i. e. 28.8 with fluchloralin 0.75 kg/ha and 29.0 with pendimethalin 1.00 kg/ha; however, as the dose of herbicide increased the number of nodules decreased to 12.4 with fluchloralin 1.25 kg/ha and 21.5 with pendimethalin 2.00 kg/ha.

Effect on Yield Attributing Traits

Both primary and secondary branches per plant differed significantly by weed control treatments (Table 5). The treatments of two hoeings either by hand or wheel hoe had higher number of branches per plant than the unweeded control. Significantly lower number of branches in one hoeing or quizalofop-ethyl or unweeded control might be due to weed competition. The maximum number of primary branches was recorded in both the

Table 4. Plant height, dry weight of plants and nodulation at 25 DAS as influenced by various treatments

Treatments	Plant height (cm)	Plant dry weight (g/plant)	No. of nodules/ plant	Dry weight of nodules/ plant (g)
Unweeded control	9.6	0.80	20.5	0.25
One hand hoeing (25 DAS)	8.9	0.80	20.5	0.23
Two hand hoeings (25 & 40 DAS)	9.7	0.79	21.6	0.26
Two hoeings with wheel hoe (25 & 40 DAS)	9.4	0.86	19.6	0.24
Fluchloralin 0.625 kg/ha	8.7	0.90	23.4	0.25
Trifluralin 0.96 kg/ha	8.8	1.00	15.8	0.13
Pendimethalin 0.45 kg/ha	10.2	0.95	25.7	0.20
Pendimethalin 0.75 kg/ha	9.0	0.92	23.2	0.20
Quizalofop-ethyl 35 g/ha	8.8	0.71	21.5	0.23
Quizalofop-ethyl 50 g/ha	9.1	0.72	18.3	0.21
Chlorimuron-ethyl 9 g/ha	7.5	0.59	20.1	0.21
Chlorimuron-ethyl 15 g/ha	7.7	0.55	18.9	0.13
LSD (P=0.05)	1.0	0.25	NS	0.07

NS–Not Significant.

Table 5. Number of branches (primary and secondary) and yield attributing characters as influenced by different treatments

Treatments	No. of primary branches/ plant	No. of secondary branches/ plant	No. of pods/plant	No. of seeds/ pod	100-seed weight (g)	Grain yield (q/ha)
Unweeded control	1.0	5.7	15.0	8.8	5.04	10.47
One hand hoeing (25 DAS)	1.6	5.9	21.0	9.0	5.07	13.85
Two hand hoeings (25 & 40 DAS)	2.6	6.2	21.9	9.2	5.82	15.10
Two hoeings with wheel hoe (25 & 40 DAS)	2.5	6.3	20.2	9.1	5.65	13.54
Fluchloralin 0.625 kg/ha	2.1	6.0	22.2	8.9	5.76	14.37
Trifluralin 0.96 kg/ha	2.1	5.3	21.0	8.6	5.66	14.20
Pendimethalin 0.45 kg/ha	1.7	6.1	22.5	8.6	5.73	13.75
Pendimethalin 0.75 kg/ha	1.7	6.3	23.0	9.2	5.63	14.47
Quizalofop-ethyl 35 g/ha	1.1	5.5	15.3	8.8	5.47	11.25
Quizalofop-ethyl 50 g/ha	1.2	5.5	16.0	8.4	5.15	11.29
Chlorimuron-ethyl 9 g/ha	3.8	4.8	13.7	8.2	5.51	1.58
Chlorimuron-ethyl 15 g/ha	4.5	4.6	13.2	7.8	4.84	2.55
LSD (P=0.05)	0.9	1.0	3.7	NS	0.63	2.99

NS–Not Significant.

doses of chlorimuron which was possibly due to phytotoxic effect initially and regeneration of the crop thereafter.

The number of secondary branches was significantly higher with two hoeings, fluchloralin and pendimethalin than the chlorimuron. The unweeded check also produced more number of secondary branches than chlorimuron. One and two hoeings, fluchloralin, trifluralin and pendimethalin at both the doses were at par and gave significantly higher number of pods per plant than the unweeded control. The post-emergence spray of quizalofop or chlorimuron at both the doses produced almost equal number of pods per plant as observed in unweeded control.

The number of seeds per pod did not vary significantly in different weed control treatments (Table 5). However, the maximum number of seeds per pod (9.2) was observed in two hand hoeings (25 and 40 DAS) and pendimethalin 0.75 kg/ha, followed by two hoeings with wheel hoe (9.1). The minimum number of seeds per pod was observed with chlorimuron at 15 g/ ha. It was possibly due to poor plant growth as the herbicide caused phytotoxicity. The toxic effect was severe at higher dose. The 100-seed weight was significantly higher in two hoeings either done with hand or wheel hoe or herbicides like pendimethalin, fluchloralin and trifluralin than the unweeded control. The minimum 100-seed weight was recorded with chlorimuron at 15 g/ha.

The highest grain yield (15.10 q/ha) was obtained in two hand hoeings at 25 and 40 DAS (Table 5) followed by pendimethalin 0.75 kg/ha. The treatments of one hoeing at 25 DAS, two hoeings with wheel hoe at 25 and 40 DAS, fluchloralin 0.625 kg/ha, trifluralin 0.96 kg/ha and pendimethalin 0.45 and 0.75 kg/ha were significantly superior to the unweeded control. The high yield was because of reduced weed competition by these weed control treatments. Chlorimuron at 9 and 15 g/ha had phytotoxic effect on the crop. This shows that phytotoxicity reduced the crop growth and ultimately reduced the grain yield. Panwar *et al*. (1999) also reported that pendimethalin at 0.75 kg/ha applied on the day of sowing recorded the highest yield of mungbean, which was at par with fluchloralin 0.7 kg/ha applied on the same day before sowing or with hand hoeing 30 DAS.

All the mechanical and herbicidal weed control treatments except post-emergence herbicides gave a marked reduction in dry matter of weeds and produced significantly more grain yield as compared to unweeded check. The weed dry matter as well as the nutrient (NPK) removal by weeds was the minimum in pendimethalin 0.75 kg/ha. Though two hand hoeings at 25 and 40 DAS produced the highest grain yield (15.10 q/ha) yet pendimethalin at 0.75 kg/ha was statistically at par with it (14.47 q/ha).

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