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Mulch and herbicide impact on weed management, nodulation and quality of soybean [*Glycine max* L. Merrill]

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ABSTRACT

A field experiment was conducted during *kharif* 2015 at N. E. Borlaug Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (Uttarakhand) to assess the impact of three herbicides *viz*. Pendimethalin, Imazethapyr and Sulfentrazone along with wheat straw mulch on weed dynamics, nodulation, yield and quality of soybean. Pendimethalin (PE) *fb* imazethapyr (PoE) + mulching @5t/ha (25 DAS) recorded significantly lower weed density and highest weed control efficiency as compared to other treatments. However, it was at par with mulching after 1st weeding at 25 DAS and mulching *fb* sulfentrazone (PoE). Pendimethalin *fb* imazethapyr + mulching (25DAS) resulted in considerably higher seed and biological yield (2.6 and 7.9 t/ha, respectively) and was comparable with weed free check (2.7 and 8.2 t/ha, respectively). Nodule number and dry weight was higher in plots applied with mulch. No significant variation in oil and protein content of soybean seeds was obtained

Key words: Herbicide, Mulch, Nodulation, Quality, Soybean.

Soybean [*Glycine max* (L.) Merrill] is an important oilseed crop which truly deserves the title "the meat that grows on plant" as it is the best source of plant protein (Arshad et al., 2006). Being a *kharif* crop, soybean is primarily affected by broad spectrum of weeds emerging at initial stages of plant growth. Besides nutrient removal, weeds causes greater reduction in soybean yield as compared to other pests owing to competition for resources. Weeds cause computational stress on its growth, especially during the first 30 days after sowing (DAS) and result in the reduction of yield up to 68% (Gaikwad and Pawar, 2002). Weeds pose a major challenge and their management is often the costliest agronomic input for the success in crop production. Herbicides are cost-effective, efficient method, but cannot be a sole and fool-proof strategy for weed management. Besides, herbicide resistance and shift in weed flora may develop due to use of same herbicide year after year. An efficient integrated weed management (IWM) module, which is cost effective, less herbicide-driven and more climate-resilient, may be required for sustainable soybean production. Mulching decreases the degree of weed incidence through inhibiting weed seed germination, smothering effect on weeds, allelopathic effects and weed seed predation through increased biological activity of soil. Besides, mulching helps to maintain soil moisture regime, reduce raindrop impact and crust formation, moderates soil

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temperature, leads to organic matter addition and increases the biological diversity of soil (Pongsa-Anutin *et al.*, 2007). Knowledge regarding the effectiveness of pre and post emergence herbicides including some new molecules in soybean grown under mollisols is limited. Moreover, an appropriate application time of mulching and its judicious integration with the herbicides needs to be standardized. Hence, the present research was planned to evaluate the effect of herbicides pendimethalin, imazethapyr and sulfentrazone along with wheat straw mulch in various combinations for effective weed management in soybean.

Materials and Methods

Field experiment was carried out in 2015 at Govind Ballabh Pant University of Agriculture and Technology, Pantnagar to investigate the effect of herbicides and mulch on weed control, yield, nodulation and quality of soybean. The experimental soil was neutral in soil reaction (pH 7.2), medium in available N (320 kg/ ha), available K (268 kg/ ha) and organic carbon (0.55%) but high in available P (28.82 kg/ ha). Twelve treatments were tested in Randomized Block Design with three replications. Soybean cv. PS-1347 was sown @ 80 kg seeds/ ha at row to row spacing of 45 cm. Three herbicides viz., pendimethalin 30 EC @ 1.0 kg a.i. /ha (PE), sulfentrazone 39.6 EC @ 0.3 kg a.i./ha (PoE) and imazethapyr 10 EC @ 0.1 kg a.i. /ha (PoE) along with mulching of wheat straw @ 5t /ha were applied individually (T1 to T4) and in different combinations (T5 to T10) and were compared with weedy check and weed free check. Pre emergence and post emergence application of herbicides was done within 2-3 DAS and 20DAS respectively. Number of nodules was counted on the roots of five sampled plants at 45 and 60 DAS and average number of nodules per plant was worked out. Nodules collected from five plants were dried in oven at 10±1°C till the constant weight. Protein yield was calculated by multiplying protein content with corresponding oven dried seed yield (kg/ ha). Seed Sample was taken from the produce of each plot and oil content was determined by Soxhlet Extraction apparatus using petroleum ether as solvent. Oil yield was calculated from oven dried seed yield.

$$\text{Oil Content (\%)} = \frac{\text{Weight of ether soluble material}}{\text{Weight of sample}} \times 100$$

$$\text{Oil Yield (kg/ ha)} = \frac{\text{Seed yield (kg/ ha)} \times \text{oil content (\%)}}{100}$$

Data on yield, nodulation and quality of soybean were statistically analysed as per standard statistical procedure. As wide variation existed in data, number and dry weight of weeds were transformed through square-root [$\sqrt{(x+0.5)}$] transformation.

Results and Discussion

The major weed flora of the experimental field consisted of *Dactyloctenium aegyptium*, *Digitaria sanguinalis, Trianthema monogyna, Celosia argentea* and *Cyperus rotundus*. Weed parameters were significantly influenced by various weed control treatments. The results revealed that pendimethalin *fb* imazethapyr + mulching (25DAS) recorded significantly lower total weed density (5.66/ m^2) and highest weed control efficiency (67.54/ m^2) at 60 DAS and was at par with mulching after 1st weeding and mulching *fb* sulfentrazone (Table-1). Among the herbicide, lowest population of sedge *(Cyperus rotundus)* was noted in the imazethapyr treated plots. The experimental findings are in conformity with Kumar *et al.* (2008) who reported that imazethapyr, being a broad spectrum herbicide was effective in killing *Cyperus rotundus* in soybean. Sulfentrazone proved to be the next best herbicide for sedges.Yelverton and Travis (2012) inferred that soil-applied sulfentrazone reduced shoot number of purple nutsedge by 95%. Among the three herbicides used, sulfentrazone showed better control of grasses, sedges and broad leaf weeds than pendimethalin or imazethapyr alone. Integration of herbicides with mulch showed a synergistic effect in controlling weeds. Weed Index value which corresponds to yield reduction due to weeds was highest in weedy check (65%) and lowest in pendimethalin *fb* imazethapyr + mulch (25DAS) (6.9%).

Seed yield and biological yield (2.6 and 7.9 t/ha, respectively) was significantly higher in

Table 1. Effect of different weed control treatments on weed density, weed control efficiency (60 DAS), yield and weed index of soybean.

Treatments	Weed density (no./m^2)				WCE	Seed yield (t/ha)	Biological yield (t/ha)	Weed Index (%)
	Grassy	Broad leaf	Sedges	Total				
Pendimethalin (PE)	5.96* (35)	4.29 (18)	2.98 (8)	7.85 (61)	46.75	1.92	5.73	31.5
Sulfentrazone (PoE)	6.45 (41)	4.57 (20)	2.81 (7)	8.28 (68)	57.34	1.98	5.99	29.4
Imazethapyr (PoE)	6.54 (42)	4.08 (16)	1.71 (2)	7.78 (60)	51.38	1.88	5.69	32.8
Mulching @ 5t/ha	6.75 (45)	4.76 (22)	3.30 (10)	8.80 (77)	33.79	1.83	5.30	34.4
Pendimethalin *fb* Sulfentrazone	5.54 (30)	3.97 (15)	2.81 (7)	7.24 (52)	59.41	2.49	6.86	10.9
Pendimethalin *fb* Imazethapyr	5.72 (32)	3.84 (14)	1.71 (2)	6.96 (48)	62.09	2.41	6.54	13.8
Pendimethalin *fb* mulching at 7 DAS	6.21 (38)	4.20 (17)	2.97 (8)	7.97 (63)	54.05	1.95	5.86	30.2
Pendimethalin *fb* Imazethapyr + mulching at 25 DAS	4.54 (20)	3.26 (10)	1.71 (2)	5.66 (32)	67.54	2.60	7.90	6.9
Mulching after 1st weeding (25 DAS)	5.07 (25)	3.13 (9)	1.71 (2)	6.03 (36)	66.20	2.59	7.86	7.5
Mulching *fb* Sulfentrazone	5.36 (28)	3.39 (11)	2.20 (4)	6.59 (43)	63.58	2.51	7.59	10.1
Weedy check	9.46 (89)	5.55 (30)	4.12 (16)	11.63 (135)	0	1.25	4.32	55.1
Weed free check	1.00 (0)	1.00 (0)	1.00 (0)	1.00 (0)	100	2.80	8.22	0
SEm±	0.28	0.32	0.18	0.49	3.09	0.13	0.23	1.49
CD (P=0.05)	0.82	0.95	0.51	1.46	9.05	0.37	0.68	4.36

Note : (Original data given in parantheses), ***** : (X + 1)1/2 transformed value, ***fb*** : followed by

weed free check and was at par with pendimethalin *fb* imazethapyr + mulch (25 DAS), mulching after 1st weeding at 25 DAS, mulching *fb* sulfentrazone. Younesabadi *et al.* (2013) also concluded that higher seed yield of soybean was recorded in pendimethalin 0.5 kg/ha + imazethapyr 0.075 kg/ha.

An examination of data revealed that among the weed control treatments, number of nodules per plant and nodule dry weight/plant was significantly higher with mulching after 1st weeding and pendimethalin *fb* imazethapyr + mulch (25DAS) at 45 and 60 DAS, respectively (Table-2). In general, mulch applied plots reported higher nodule number as compared to herbicides treated plots. This result is in conformity with the results of Chikoye *et al.* (2014) who concluded that nodule number was highest in weed free check. They found that nodule number and dry weight were lowest in plots that received pendimethalin at 4 and 8 kg/ha. A different view point was presented by Billore *et al.* (1999) who found that the maximum and minimum number of nodule were associated with the application of imazethapyr @75g/ha and 2 hand weedings, respectively. Lowest nodule count in case of hand weeding may be due to soil disturbances which might have had affected the root growth and consequent poor nodulation.

Significantly, higher nutrient uptake was obtained in pendimethalin *fb* imazethapyr + mulching (25DAS) and was at par with mulching after 1st weeding and mulching *fb* sulfentrazone which might be attributed to better proliferation of root system, high dry matter accumulation and lesser removal of weeds in these treatments. Similar findings were also reported by Monsefi *et al.* (2013).

Minimum value of protein yield was recorded in weedy check. Higher accumulation of photosynthates and nutrient uptake during the crop growth stage in weed free, pendimethalin *fb* imazethapyr + mulch (25DAS), mulching after 1st weeding and mulching *fb* sulfentrazone might have resulted in higher protein yield. The protein and oil content did not differ significantly in weed control treatments. An inverse relationship between oil and protein content was found which

Table 2. Effect of different weed control treatments on nodulation, nutrient uptake in seed and quality parameters of soybean.

Treatments	Nodule number / plant		Nodule dry weight / plant (g / plant)		Nutrient uptake (kg / ha) at harvest			Protein content (%)	Oil content (%)
	45 DAS	60 DAS	45 DAS	60 DAS	N	P	K		
Pendimethalin (PE)	53	42	170	118	104.6	12.2	25.9	38.7	19.1
Sulfentrazone (PoE)	51	48	156	92	107.8	12.5	25.9	38.7	20.8
Imazethapyr (PoE)	56	46	166	107	103.8	12.2	24.3	39.2	18.9
Mulching @ 5t / ha	61	53	185	135	100.6	11.4	22.9	38.9	21.3
Pendimethalin *fb* Sulfentrazone	59	41	195	140	141.1	15.6	34.5	40.2	20.1
Pendimethalin *fb* Imazethapyr	54	43	167	133	134.8	15.6	32.5	39.7	20.5
Pendimethalin *fb* mulching at 7 DAS	65	49	164	157	113.5	12.4	26.8	41.2	19.6
Pendimethalin *fb* Imazethapyr + mulching at 25 DAS	62	59	235	170	156.1	17.1	36.8	42.6	18.3
Mulching after 1st weeding (25 DAS)	68	54	241	165	150.7	18.0	36.0	41.4	18.4
Mulching *fb* Sulfentrazone	64	50	208	152	143.8	16.6	35.2	40.6	18.7
Weedy check	58	51	160	92	67.6	7.7	15.6	38.2	18.9
Weed free check	82	70	264	185	169.8	18.6	39.9	43.1	20.5
SEm±	2.94	2.55	10.83	7.47	7.4	0.8	1.8	2.2	1.1
CD (P=0.05)	8.61	7.49	31.75	21.91	21.8	2.4	5.3	NS	NS

Note : *fb* : followed by

might be due to competition for glucose monomers. This is in conformity with the reports of Younesabadi *et al.* (2013).

Thus, pendimethalin *fb* imazethapyr + mulch (25 DAS), mulching after 1st weeding and mulching *fb* sulfentrazone gave better weed control and higher yield.

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