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Short communication

Crop geometry and weed management effect on weed dynamics in soybean

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Soybean (*Glycine Max*. L. Merrill.) grown in rainy season faces severe weed competition. Weed competition in soybean at early stage of crop growth is critical, as it causes yield losses up to 35 to 50% (Tiwari and Kurchania 1990). The incessant rains do not permit timely inter-cultivations and manual control of weeds on account of high cost and labour shortage during need of weeding. There is a need for alternative methods for reducing the weed load during crop weed competition period of first 30-45 days. Therefore, present investigation was conducted to see the effect of crop geometry and weed management practices on growth and yield of soybean.

Experiment was conducted at Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar (Maharashtra) during *Kharif* (rainy) season, 2015. The experiment was laid out in factorial randomized block design consisted of two factors, first crop geometry, *viz.* 45 x 5 and 30 x 10 cm and second factor was weed management practices *viz*. pendimethalin as pre-emergence (PE) 0.75 kg/ha *fb* one hand weeding at 30 DAS (days after sowing), pendimethalin as PE 0.75 kg/ha *fb* tank mix imazethapyr + propaquizafop (80 + 60 g/ha) at 25 DAS, one hoeing at 15 DAS *fb* hand weeding at 30 DAS, weedy check and weed free check. The soybean variety used was '*KDS-344*' (*Phule Agrani)*. The gross and net plot size were 6.0 x 5.4 and 5.6 x 4.5 m, respectively. The soil of experimental site was silty clay in texture, medium in available nitrogen (204 kg/ha), phosphorous (18 kg/ha) and very high in potassium (548 kg/ha) with pH of 8.18 and electrical conductivity of 0.16 ds/m. The recommended fertilizer dose (75:50:00 N, P_2O_5 and K_2O kg/ha) was applied as basal through urea and single super phosphate at the time of sowing. Growth and yield parameters of soybean crop, total weed density (no./ m), weed dry matter (g/m) were periodically recorded by following standard methodology, Weed control efficiency (%), weed index (%), herbicide efficiency index (%) and crop resistance index (%) were calculated by using standard. The herbicide pendimethalin 38.7% CS was used as pre-emergence while imazethapyr 10% SL, propaquizafop 10% EC were applied as post-emergence by using 500 litre spray volume through knapsack spray pump fitted with flat fan nozzle.

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Weed density and biomass

Crop geometry of 45 x 5 cm spacing recorded significantly lowest total weed density (3.55, 3.21 and 3.22 (no./m^2) at 28, 56 DAS and at harvest, respectively) as compared to 30 x 10 cm spacing (**Table 1**). This might be due to wider rows and closer plants hence significantly reduced weed population because increased competition from higher density of crop plants resulted in suppression of weeds. These results were in close conformity with the finding of Bishnoi and Mays (2002). Among the weed management practices, pendimethalin PE 0.75 kg/ha *fb* tank mix imazethapyr + propaquizafop (80 + 60 g/ha) at 25 DAS recorded significantly lowest weed density while pendimethalin PE 0.75 kg/ ha *fb* one hand weeding at 30 DAS recorded lowest weed density at 56 DAS and at Harvest. This might be due to application of pre-emergence herbicide, which effectively hindered the germination of weed seeds while application of post-emergence tank mix imazethapyr + propaquizafop (80 + 60 g/ha) at 25 DAS or hand weeding at 30 DAS effectively controlled latter emerged weeds. These results were in close conformity with Jadhav *et al.* (2013).

Soybean dibbled at geometry of 45 x 5 cm recorded significantly the lowest weed dry matter at harvest (5.28 g/m^2) as compared to 30 x 10 cm spacing (**Table 1**). It might be due to increased competition from higher density of crop plants resulted in reducing weed density and thereby reduced biomass of weed (g/m^2). These results were

in close conformity with the finding of Bishnoi and Mays (2002). Among the weed management treatments, pendimethalin PE 0.75 kg/ha *fb* one hand weeding at 30 DAS registered significantly lowest weed biomass at harvest (4.04 g/m^2) as compared to the rest of the treatments.

Weed control efficiency

Crop geometry 45 × 5 cm spacing recorded significantly higher weed control efficiency (74%) at harvest as compared to 30 × 10 cm spacing. Pendimethalin 0.75 kg/ha *fb* one hand weeding at 30 DAS and pendimethalin 0.75 kg/ha *fb* tank mix application of imazethapyr + propaquizafop (80 + 60 g/ha) at 25 DAS recorded highest weed control efficiency of 89 and 88%, respectively at harvest (**Table 1**).

Weed index and herbicide efficiency index

Crop geometry of 45 x 5 cm spacing recorded numerically lowest weed index (11.7%) and highest herbicide efficiency index value (1.3) as compared to 30 x 10 cm spacing (12.1 and 0.5, respectively). This might be due to less crop-weed competition during the growing period of the crop resulted in better yield. Among the weed management practices pendimethalin 0.750 kg/ ha *fb* one hand weeding at 30 DAS (3.86) and pendimethalin 0.75 kg/ha *fb* tank mix imazethapyr + propaquizafop (80 + 60 g/ha) at 25 DAS (3.96) recorded the lowest weed index indicating minimum yield loss due to weeds compared to weed free check. The herbicide efficiency index value was numerically highest in pendimethalin 0.75 kg/ha *fb* one hand weeding at 30 DAS (2.04) followed by pendimethalin 0.75 kg/ha *fb* tank mix imazethapyr + propaquizafop (80 + 60 g/ha) at 25 DAS (1.43) (**Table 1**). The minimum value of weed index with pendimethalin 0.75 kg/ha *fb* one hand weeding at 30 DAS indicated less yield losses due to weeds because of less crop-weed competition during the growing period of the crop resulted in better yield. These results are close conformity with the finding of Nainwal *et al.* (2010).

Crop resistance index

Crop geometry of 45 x 5 cm spacing recorded significantly highest crop resistance index value (9.6) as compared to 30 x 10 cm spacing (6.7). Among the integrated weed management treatments, pendimethalin 0.75 kg/ha *fb* one hand weeding at 30 DAS recorded significantly highest crop resistance index (15.2) followed by the pendimethalin 0.750 kg/ ha *fb* tank mix imazethapyr + propaquizafop (80 + 60 g/ha) at 25 DAS (12.9) (**Table 1**).

Grain and straw yield

Crop geometry of 45×5 cm recorded significantly highest soybean grain yield (2.08 t/ha) and straw yield (2.85 t/ha) as compared to 30 × 10 cm spacing (1.83 t/ha) and (2.23 t/ha), respectively (**Table 2**). Results suggested that in wider spacing, lowest weed competition due to suppression of weeds and more interception of sun light by crop increased photosynthetic activities resulted in better

Table 1. Effect of crop geometry and weed management practices on weed dynamics

Treatment	Total weed count (no./m^2)			Weed dry matter (g/m^2) at harvest	WCE (%) at harvest	Weed index at harvest	Herbicide efficiency index at harvest	Crop resistance index at harvest
	28 DAS	56 DAS	At harvest					
Crop geometry								
30 x 10 cm	3.76 (20.06)	3.45 (17.79)	3.46 (17.99)	5.63 (49.91)	71.08	12.1	0.53	6.70
45 x 5 cm	3.55 (18.65)	3.21 (16.38)	3.22 (16.59)	5.28 (46.25)	73.85	11.6	1.27	9.58
LSD (p=0.05)	0.15	0.19	0.19	0.07	0.58	NS	0.01	0.61
Weed management								
Pendimethalin PE 0.75 kg/ha *fb* one hand weeding at 30 DAS	3.89 (14.66)	2.44 (5.49)	2.44 (5.49)	4.04 (15.85)	89.42	3.9	2.04	15.24
Pendimethalin PE 0.75 kg/ha *fb* tank mix imazethapyr + propaquizafop (80 + 60 g/ha) at 25 DAS	1.67 (2.33)	2.59 (6.32)	2.59 (6.32)	4.39 (18.88)	87.69	4.0	1.43	12.89
One hoeing at 15 DAS *fb* hand weeding at 30 DAS	3.96 (15.32)	2.74 (7.15)	2.74 (7.15)	4.47 (19.60)	85.21	9.0	1.03	11.56
Weedy check	8.06 (64.48)	8.18 (66.48)	8.24 (67.48)	13.66 (186.1)	0.00	42.7	0.0	1.0
Weed free check	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	100.0	0.0	0.0	0.0
LSD (p=0.05)	0.24	0.30	0.30	0.10	0.92	1.9	0.01	0.97

Original values are in parentheses transformed to $\sqrt{x + 0.5}$; PE= Pre-emergence

Table 2. Effect of crop geometry and weed management on plant growth and yield and economics of soybean

Treatment	Grain yield (t/ha)	Straw yield (t/ha)	Cost of cultivation (x10^3 `/ha)	Net returns (x10^3 `/ha)	B : C Ratio
Crop geometry					
30 x 10 cm	1.83	2.23	38.39	30.41	1.81
45 x 5 cm	2.08	2.85	40.18	38.20	1.96
LSD (p=0.05)	0.03	0.03	-		
Weed management					
Pendimethalin PE 0.75 kg/ha *fb* one hand weeding at 30 DAS	2.17	2.71	37.65	43.85	2.16
Pendimethalin PE 0.75 kg/ha *fb* tank mix imazethapyr + propaquizafop (80 + 60 g/ha) at 25 DAS as POE	2.15	2.71	36.65	44.36	2.21
One hoeing at 15 DAS *fb* hand weeding at 30 DAS	2.00	2.45	37.83	37.55	1.99
Weedy check	1.26	2.19	31.33	16.40	1.52
Weed free check	2.19	2.71	52.99	29.36	1.55
LSD (p=0.05)	0.04	0.05	-		

HW-Hand weeding, DAS-Days after sowing, *fb*- Followed by, PE- Pre-emergence and PoE- Post-emergence

utilization of nutrients, light, moisture and space by soybean crop for growth and development which reflected its effect into reproductive growth of soybean crop in terms of yield. These results are close conformity with the findings of Pandya *et al.* (2005). Weed free check treatment recorded significantly highest soybean grain yield (2.2 t/ha) and straw yield (2.7 t/ha), but it was at par with pendimethalin 0.75 kg/ha *fb* one hand weeding at 30 DAS (2.2 t/ha) and (2.7 t/ha), respectively. These results were in close conformity with the findings Habimana *et al.* (2013).

Economics

Crop geometry 45 x 5 cm spacing recorded highest net monetary returns (` 38205/ha) and B:C Ratio (1.96) as compared to 30 × 10 cm crop geometry (` 30411/ha) and (1.81), respectively (**Table 2**). This might be due to higher grain and straw yield. Pendimethalin 0.75 kg/ha *fb* tank mix imazethapyr + propaquizafop (80 + 60 g/ha) at 25 DAS recorded significantly highest net monetary returns (` 44362/ha) and B: C Ratio (2.21) but was at par with pendimethalin 0.75 kg/ha *fb* one hand weeding at 30 DAS (` 43858/ha) and (2.16). These results are close conformity with the findings of Sankaranarayanan (2002).

It was concluded that geometry of 45 x 5 cm spacing as well as both weed management practices, *viz*. pendimethalin PE 0.75 kg/ha *fb* one hand weeding at 30 DAS and pendimethalin PE 0.75 kg/ha *fb* tank mix imazethapyr + propaquizafop (80 + 60 g/ha) at 25 DAS recorded significantly lowest total weed count, weed dry matter and weed index while higher WCE, herbicide efficiency index, crop resistance index and higher soybean grain, straw yield, net returns and B:C ratio.

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