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SEED YIELD AND YIELD COMPONENTS OF SESAME AS AFFECTED BY VARIOUS WEED CONTROL METHODS

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Abstract

Weed control strategy greatly influences on weed infestation and yield of sesame. An experiment was conducted at Regional Agricultural Research Station, Ishurdi, Pabna during Kharif-1 season of two consecutive years 2015-16 and 2016-17 to find out the suitable weed control methods in sesame. It comprises five weed control methods viz., Application of Panida (T_1), Application of Panida with one hand weeding at 20 DAE (T_2), One hand weeding at 20 DAE (T_3), Two hand weedings at 20 and 40 DAE (T_4) and Control (no weeding) (T_5). The experiment was laid out in a randomized complete block design with three replications. Among the weed species, *Cyperus rotundus and Digitaria sangunalis* were the most abundant weeds. Application of Panida with one hand weeding at 20 DAE (T_2) gave the lowest weed density, weed biomass and the highest weed control efficiency followed by application of Panida (T_1) in both years. Weed biomass influenced negatively on plant height, number of capsule plant^{-1}, seed yield and stalk yield. The maximum seed yield and stalk yield were also obtained from T_2 which was statistically similar to T_1 treatment and the minimum seed yield from T_5. Economic analysis indicated that T_2 gave higher gross return but T_1 provided higher gross margin and benefit cost ratio. The treatment, T_4 showed higher total variable cost due to the high cost of labour for hand weeding with the increase of variable cost, which affected the marginal return and benefit-cost ratio. However, based on the economic point of view, application of Panida in pre-emergence condition (T_1) was a profitable and suitable weed control method in summer sown sesame.

Introduction

Sesame [*Sesamum indicum* (L.)] is one of the important edible oilseeds cultivated crop in Bangladesh. It's oil content generally varies from 46 to 52% and protein content between 20-26%. The production of this crop is 35000 metric tons from 93000 acres of land in Bangladesh (BBS, 2019). It is cultivated almost everywhere in the country in the early summer (Kharif-1) under rain fed condition. Severe weed competition is one of the major constraints of low yield of sesame. Prevalence of high temperature with high relative humidity and frequent rainfall during the crop season leads to become wet and moist soil which is favorable for flourishing weed growth and slower plant growth, particularly during early growth stages. A critical period of weed competition in sesame is between 15 and 30 days after seedlings emergence and weeds alone reduce about 50-78% seed yield of sesame (Karnas *et al.,* 2019; Amare *et al.,* 2011). Besides, the rising cost of labour and difficulty of mechanical weeding due to moist soil condition in the summer season call for an alternate weed control measure (Punia *et al.*, 2001).

Though manual weeding is effective and eco-friendly yet they are tedious and time- consuming. However, chemical weed management is more favourable and effective as they are quick in action, selective in nature, cost effective and efficient to control weeds during the critical period (Jain *et al.*, 2001; Jain and Badkul, 2013). Many herbicides are presently used for controlling weeds in rice field. But the information about the weed control methods in summer sown sesame is meager. Therefore, the present experiment has been undertaken to find out the appropriate weed control methods for summer sesame.

Materials and Methods

Location, soil and climatic condition

The present study was carried out at the Regional Agricultural Research Station, Ishurdi, Pabna during two consecutive years, 2016 and 2017 (Kharif-1 season), geographical position: 24.11° N; 89.07° E; under the AEZ-11 (High Ganges River Flood plain) (FRG, 2012). The soil of the experimental site was medium-high and clay loam texture having 1.22% organic matter, pH 7.40, 0.07% total nitrogen (N), 0.36 meq 100 g^{-1} soil potassium (K), 10.6 ppm phosphorus (P), 7.2 ppm sulfur (S) and 1.13 ppm zinc (Zn). It is under sub-tropical humid climatic conditions and the detailed daily maximum, minimum temperature and rainfall were presented in Fig. 1 and Fig. 2. The average daily minimum and maximum temperatures were 23.49°C and 33.49°C in the first year, respectively and 24.57 °C and 34.04 °C in the second year during the growing period (March-July). However, the differences in minimum and maximum temperatures were slightly less in the first season than the second season. The total rainfall (March-July) was 1221 mm in 2016 and 4768 mm in 2017, which was higher than first season.

Treatments and design

The experiment was laid out in a randomized complete block design (RCBD) with 3 replications. The unit plot size was 3 m × 4 m. Five weed control methods were included in this study. These were application of Panida (T_1), application of Panida with one hand weeding at 20 DAE (T_2), one hand weeding at 20 DAE (T_3), Two hand weedings at 20 and 40 DAE (T_4) and Control (no weeding) (T_5). Herbicide, Panida 33 EC (Pendimethalin, 2.5 L ha^{-1}) was applied as a pre-emergence condition at moist soil condition just after post sowing irrigation for proper seed germination. Spraying was done at the rate of 5 mL Panida per liter water with Knapsack charger hand sprayer fitted with T-Jet nozzle.

Field experiment

Sesame var. BARI Til-4 was used in the experiment. Seeds were sown on 10 April and 14 March, 2016 and 2017 respectively in line by hand maintaining 30 cm rows with continuous seeding. Fertilizer was applied @ 58-25-40-20-2-1 kg ha^{-1} of N-P-K-S-Zn-B respectively in the form of urea, triple superphosphate, muriate of potash, gypsum, zinc sulphate and boric acid, respectively (FRG, 2012). Half of N and all other fertilizers were applied at final land preparation and the remaining N was applied as top- dressed at 25 days after emergence. Tilt 250 EC (Propiconazole) and Nitro [Chlorpyrifos (50%) + Cypermathrin (5%)] were sprayed at after flowering to control diseases and insects. No irrigation was applied and weeding was done as per treatments. The crop was harvested on 11 July and 14 June, 2016 and 2017 respectively.

Data collection

Species wise weed population was counted at random from an area of one 1 m^2 per each plot with quadrate (1m x 1m) at 30 DAE (days after emergence) and the dry weight of weed species was determined after in an oven-drying for 72 hours at 70°C. The weight of the dried samples was taken and the average data were expressed as weed biomass (g m^{-2}). The frequency of different weeds was determined and the density of each species was calculated according to Odum (1971).

$$\text{Weed density (no. m}^{-2}) = \frac{\text{Total number of weeds}}{\text{Total survey areas (m}^{-2})}$$

$$\text{Relative weed density} = \frac{\text{Density of each weed species}}{\text{Total density of all weed species}} \times 100$$

Weed control efficiency (WCE) was calculated according to the formulae of Mani *et al.* (1973).

$$\text{WCE (\%)} = \frac{\text{Dry weight in weedy check plot - dry weight in treatment plot}}{\text{Dry weight in weedy check plot}} \times 100$$

Weed persistence index (WPI) was computed using the given formula as suggested by Mishra and Mishra (1997)

$$\text{WPI} = \frac{\text{Weed population in control plot}}{\text{Weed population in treated plot}} \times \frac{\text{Weed dry weight in treated plot}}{\text{Weed dry weight in control plot}}$$

Five plants of sesame in each plot were selected randomly to gather data on yield components. Data on plant population m^{-2} of sesame were recorded at physiological maturity and the crop was harvested plot-wise at full maturity. The harvested crop was bundled separately with tag and then brought to the threshing floor. Yield and yield components were recorded after harvesting the crop. Seed and stalk were dried in the sun to minimize the moisture and converted to yield (kg ha^{-1}). Data were recorded on plant height (cm), branches $plant^{-1}$ (no.), capsules $plant^{-1}$ (no.), capsule length (cm), seeds $capsule^{-1}$ (no.), 1000-seed weight (g), seed yield (kg ha^{-1}) and stalk yield (kg ha^{-1}).

Statistical Analysis

The analysis of variance (ANOVA) of collected data were performed statistically using 'R' software (version: R-3.3.1) (R Core Team, 2016) and mean separation was done as least significant difference (LSD) at 5% level of significance (Gomez and Gomez, 1984). Yield and yield components of sesame did not vary year to year so pooled analysis was done.

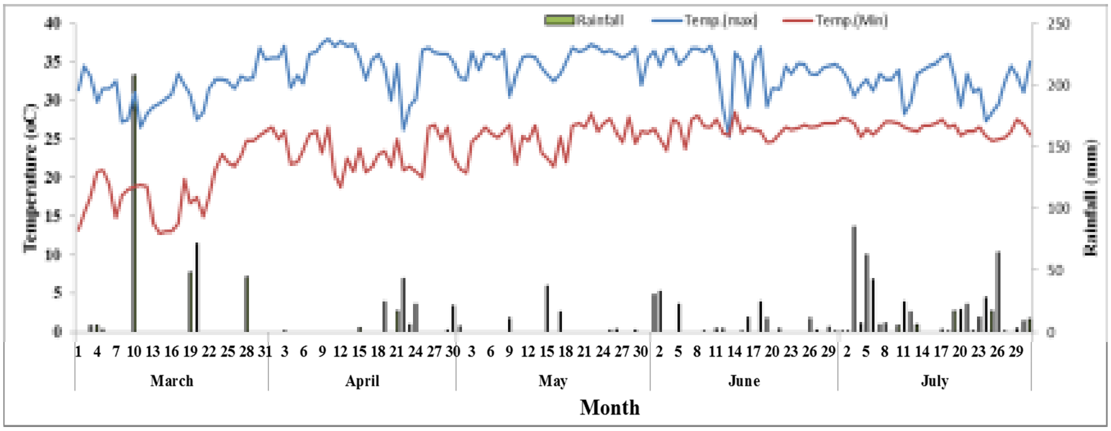

Fig. 1. Daily maximum, minimum temperature and rainfall during the cropping season 2016 at Ishurdi.

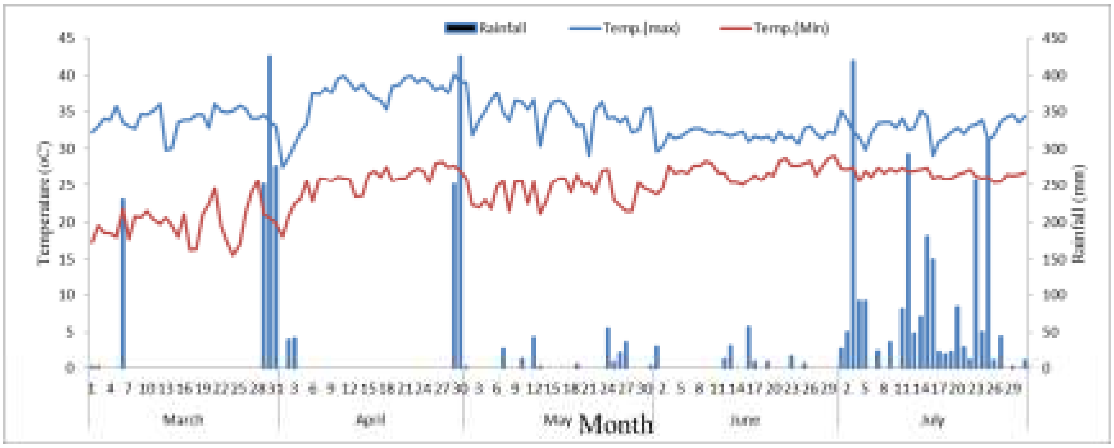

Fig. 2. Daily maximum, minimum temperature and rainfall during the cropping season 2017 at Ishurdi.

Results and Discussion

Weed indices

The number of weed species and relative weed density was affected by different weed control methods at 30 DAE (Table 1). It was observed that *Cyperus rotundus* (Mutha), *Digitaria sangunalis* (Anguli), *Cynodon dactylon* (Durba) and *Enhydra fluctuans* (Helancha) were the common weeds in sesame field. Among the weed species, *Cyperus rotundus and Digitaria sangunalis* were the most dominant weeds. Khan *et al.* (2011) also reported that these weeds were grown abundantly in kharif-1 season in North-west region in Bangladesh. The highest number of weeds (167 m^{-2} in 2015-16 and 355 m^{-2} in 2016-17) were recorded from control treatment (T_5) and the lowest (67 m^{-2} in 2015-16 and 115 m^{-2} in 2016-17) from application of Panida with one hand weeding at 20 DAE (T_2), which was statistically similar with T_1. Application of Panida and hand weeding controlled *Digitaria sangunalis* and other grass weeds and controlled less of *Cyperus rotundus* and broad-leaf weeds, which reduced the density of grass weed than sedge and broad-leaf weeds. The weed density was higher in second growing period (2016-17) than first growing period (2015-16). This might be due to higher minimum and maximum temperatures and total rainfall in the second growing season than the first growing season.

Weed biomass was significantly influenced by different weed control methods (Table 2). The highest weed biomass (155 g $m^{-2}$and 172 g m^{-2}) was obtained from untreated control (T_5) in 2015-16 and 2016-17, respectively and the lowest dry weight (24 g $m^{-2}$and 25 g m^{-2}) was calculated from T_2 in 2015-16 and 2016-17, respectively. The weed control efficiency among the weed control methods ranged from 76 to 85% in 2015-16 and 72 to 85% in 2016-17 (Table 2). The highest weed control efficiency was found in application of herbicide with hand weeding at 20 DAE (T_2), which was 85% in both years. Weed persistence index (WPI) was also varied from 0.45 to 0.38 in 2015-16 and from 0.82 to 44 in 2016-17; where application of herbicide with one hand weeding at 20 DAE (T_2) gave less WPI in both years. This may be attributed to better control of weeds due to suppress of weed emergence through herbicide and weeding under critical period of weed competition critical which might had provided higher weed control efficiency. The results corroborate the findings of Rahman *et al.* (2017), who stated that pre-emergence of herbicide with one weeding at 20 DAE provides less weed infestation, weed biomass and high weed control efficiency in sesame.

Table 1. Effect of weed control methods on different weed species' population and their relative weed density in sesame field at Ishurdi during 2015-16 and 2016-17

Treatments	**Local name**	**Scientific name**	**Type**	**2015-16**		**2016-17**	
				Weed density (no. m^{-2})	**Relative weed density (%)**	**Weed density (no. m^{-2})**	**Relative weed density (%)**
T_1	Mutha	*Cyperus rotundus*	Sedge	33	49	123	99
	Anguli/Khuda Anguli	*Digitaria sangunalis/ Digitaria ischaemum*	Grass	19	28	1	1
	Others	-	Broadleaf	10	15	0	0
	Durba	Cynodon dactylon		6	9	0	0
	Total			68	100	124	100
T_2	Mutha	*Cyperus rotundus*	Sedge	40	60	114	99
	Anguli	*Digitaria sp.*	Grass	18	27	1	1
	Helancha	*Enhydra fluctuans*	Broadleaf	2	3	0	0
	Durba	Cynodon dactylon		4	6	0	0
	Other			3	4	0	0
	Total			67	100	115	100
T_3	Mutha	*Cyperus rotundus*	Sedge	36	41	155	80
	Anguli	*Digitaria sp.*	Grass	52	59	38	20
	Total			88	100	193	100
T_4	Mutha	*Cyperus rotundus*	Sedge	39	45	165	86
	Anguli	*Digitaria sp.*	Grass	47	55	37	19
	Total			86	100	192	100
T_5	Mutha	*Cyperus rotundus*	Sedge	81	49	260	73
	Anguli	*Digitaria sp.*	Grass	86	51	95	27
	Total			167	100	355	100
LSD $_{(0.05\%)}$		-	-	9.74	-	10.31	-
CV (%)		-	-	5.43	-	2.79	-

T_1: Application of Panida; T_2: Application of Panida with one hand weeding at 20 DAE; T_3: One hand weeding at 20 DAE; T_4: Two hand weeding at 20 and 40 DAE; T_5: Control (unweeded).

Table 2. Weed biomass, weed control efficiency and weed persistence index of sesame in different weed control methods at Ishurdi during 2015-16 and 2016-17

Treatments	Weed biomass (g m^{-2})		Weed control efficiency (%)		Weed persistence index	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
T_1	37	49	76	72	0.58	0.82
T_2	24	25	85	85	0.38	0.45
T_3	31b	44	80	74	0.38	0.47
T_4	33	41	79	76	0.41	0.44
T_5	155	172	-	-	-	-
LSD $_{(0.05\%)}$	9.02	5.25	-	-	-	-
CV (%)	8.53	4.20	-	-	-	-

T_1: Application of Panida; T_2: Application of Panida with one hand weeding at 20 DAE; T_3: One hand weeding at 20 DAE; T_4: Two hand weeding at 20 and 40 DAE; T_5: Control (unweeded).

Yield components and yield of sesame

Plant population had no significant difference among different weed control methods (Table 3). Plant population varied 28-32 m^{-2}. However, higher plant population was found under application of Panida with hand weeding at 20 DAE, while lower plant population in weedy check. Hossain *et al.* (2010) also found similar results. The plant height was affected significantly by the treatments (Table 3). The maximum plant height was found in application of herbicide with one hand weeding at 20 DAE (124 cm), which was statistically similar at application of Panida (T_1) and one hand weeding at 20 DAE (T_3). The lowest plant height was recorded in untreated plot (110 cm). The plant height was increased in better weed control management at proper time possibly due to consume of maximum utilization of moisture and nutrients by crop (Riaz *et al.*, 2006). The number of branches plant^{-1} had not significant effect among the treatments, which ranged 2.87-1.97. Application of herbicide with one hand weeding at 20 DAE (T_2) gave the maximum number of capsule per plant (45) which was statistically at par to T_1. The lowest number of capsule per plant (37) recorded in T_5 and T_5. The results were in agreement with the findings of Ambika and Sundari (2019) that pre-emergence herbicide treatment along with one hand weeding resulted in maximum number of capsules plant^{-1} of sesame. Capsule length and seeds capsule^{-1} had no significant effect among the treatments. Capsule length ranged 1.97 -1.73 cm and number of seeds capsule^{-1} varied 77-70. The highest thousand seed weight was recorded from T_2, which was statistically similar to treatment T_1 and T_3, and the lowest thousand seed was calculated in T_5. Similar results have also been reported by Akter (2015), who mentioned that 1000-seed weight was higher when two hand weeding was done or herbicide applied at pre-emergence condition. The seed yield of sesame was significantly influenced by different weed management methods (Table 4.). Higher seed yield (805 kg ha^{-1}) was obtained from T_1 followed by T_2 treatment and lower seed yield was gained at T_5. Seed yield was increased 130% in T_2 over control which was followed by T_1. The improvement in seed yield under these treatments may be attributed to more weed reduction at critical growth stages of crop which favored healthy plant growth to produce maximum number of capsule plant^{-1} and thousand seed weight which gave higher yield of sesame. The results were in agreement with the findings of Rahaman *et al.* (2017) that pre-emergence herbicide treatment along with one hand weeding resulted in maximum seed yield of sesame. But Hossain *et al.* (2020) reported that two hand weedings at 15 and 30 DAS gave higher seed yield in sesame.

Application of Panida with one hand weeding at 20 DAE (T_2) and application of Panida (T_1) also gave the highest stalk yield (3361 kg ha^{-1}, 3167 kg ha^{-1} respectively). Unweeded treatment (T_5) recorded the lowest stalk yield (1180 kg ha^{-1}) due to severe weed competition with sesame which resulted in stunted growth and lower yield. This is in agreement with the findings of Mruthul *et al.* (2015).

Table 3. Yield contributing characters of sesame as affected by different weed control methods at Ishurdi during 2015-16 and 2016-17 (Pooled)

Treatments	**Plant population m^{-2}**	**Plant height (cm)**	**Branches $plant^{-1}$ (no.)**	**Capsules $plant^{-1}$ (no.)**	**Capsule length (cm)**
T_1	31	123	2.87	43	1.97
T_2	32	124	2.63	45	1.87
T_3	30	119	1.97	38	1.75
T_4	30	117	2.07	37	1.80
T_5	28	110	2.40	37	1.73
$LSD_{(0.05)}$	NS	4.66	NS	4.57	NS
CV (%)	11.16	3.21	5.11	9.29	12.48

T_1: Application of Panida; T_2: Application of Panida with one hand weeding at 20 DAE; T_3: One hand weeding at 20 DAE; T_4: Two hand weeding at 20 and 40 DAE; T_5: Control (unweeded); CV = Coefficient of Variation

Table 4. Yield and yield contributing characters of sesame as affected by different weed control methods at Ishurdi during 2015-16 and 2016-17 (Pooled)

Treatment	**Seeds $capsule^{-1}$ (no.)**	**1000-seed weight (g)**	**Seed yield (Kg ha^{-1})**	**Stalk yield (Kg ha^{-1})**	**Seed yield increase over control (%)**
T_1	74	1.76	771	3167	120
T_2	77	1.91	805	3361	130
T_3	73	1.74	524	1583	50
T_4	70	1.69	514	1972	47
T_5	71	1.49	350	1180	0
$LSD_{(0.05\%)}$	NS	0.17	43.56	195	-
CV (%)	8.54	8.23	6.00	7.07	-

T_1: Application of Panida; T_2: Application of Panida with one hand weeding at 20 DAE; T_3: One hand weeding at 20 DAE; T_4: Two hand weeding at 20 and 40 DAE; T_5: Control (unweeded); CV = Coefficient of Variation.

According to regression analysis of the obtained results, plant height, number of capsule $plant^{-1}$, seed yield and stalk yield were changed to various weed biomass under different treatments (Fig. 3). Weed biomass accounted for 75% variations in plant height, 23% variations in capsule $plant^{-1}$, 52% variations in seed yield and 39% variations in stalk yield, which could result to the competition for growth resources between weeds and crop. The association analysis was also performed using two years mean data among weed biomass and yield attributing traits, and the results revealed that weed biomass showed a negative correlation with plant height (r = -0.87), number of capsule plant^{-1} (r = -0.48), seed yield (r = -0.73) and stalk yield (r = -0.63). These results are agreement with the findings of Aktar *et al.* (2013), who stated that increasing trend of weed biomass decreases the yield of the crop.

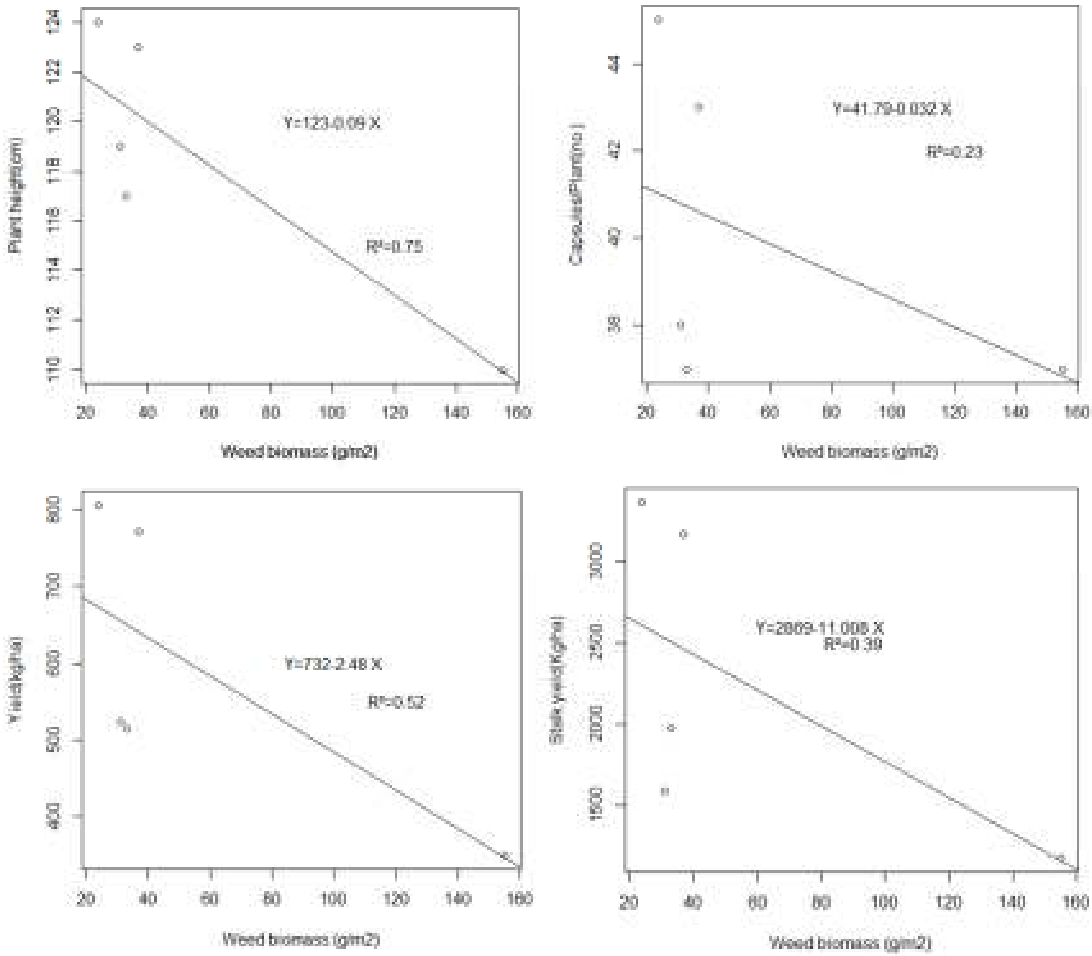

Fig. 3. Plant height, capsule plant^{-1}, seed yield and stalk yield depended on the weed biomass under different weed control methods.

Economics

Economic analysis of different weed control methods on sesame has shown in Table 5. The highest gross return (Tk. 56350 ha^{-1}) was registered with application of Panida with one hand weeding at 20 DAE followed by application of Panida and the least gross return was registered in unweeded control (Tk. 24500 ha^{-1}). But two hand weeding at 20 DAE and 40 DAE attributed the highest cost (Tk. 42750 ha^{-1}) and less cost in (Tk. 18750 ha^{-1}) in control (T5). The highest gross margin (Tk. 33189 ha^{-1}) and BCR (2.60) were obtained from pre-emergence of Panida followed by pre-emergence of Panida with one hand weeding at 20 DAE. This might be due to high cost of labour for hand weeding resulting in the increase of variable cost and reducing the marginal return, which affect the benefit cost ratio. These findings are supported by other workers (Rahman *et al.*, 2017; Ambika and Sundari, 2019).

Table 5. Economic performance of sesame under different weed control methods

Treatments	**Gross return (Tk. ha^{-1})**	**Total variable cost (Tk. ha^{-1})**	**Gross margin (Tk. ha^{-1})**	**BCR**
Application of Panida	53970	20781	33189	2.60
Application of Panida with one hand weeding at 20 DAE	56350	32781	23569	1.72
One hand weeding at 20 DAE	36680	30750	5930	1.19
Two hand weeding at 20 and 40 DAE	35980	42750	-6770	0.84
Control	24500	18750	5750	1.31

Cost:- Sesame : Tk.70 kg^{-1}, Panida 33 EC: Tk. 325 per 400 mL, Urea: Tk. 16 Kg^{-1}, TSP: Tk. 22 Kg^{-1}, MoP: Tk. 15 Kg^{-1}, Labour : Tk. 400 eight hour^{-1} head^{-1}

Conclusion

Application of herbicide, Panida 33 EC in pre-emergence condition with one hand weeding at 20 days after emergence decreased the weed infestation and weeds biomass, and increased the weed control efficiency, which was followed by the application of Panida 33 EC in pre-emergence. Although, the treatment of application of Panida 33 EC in pre-emergence condition with one hand weeding at 20 days after emergence gave the highest seed yield, on the basis of economic point of view application of Panida 33 EC in pre-emergence condition was profitable and suitable weed control method in summer sown sesame.

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