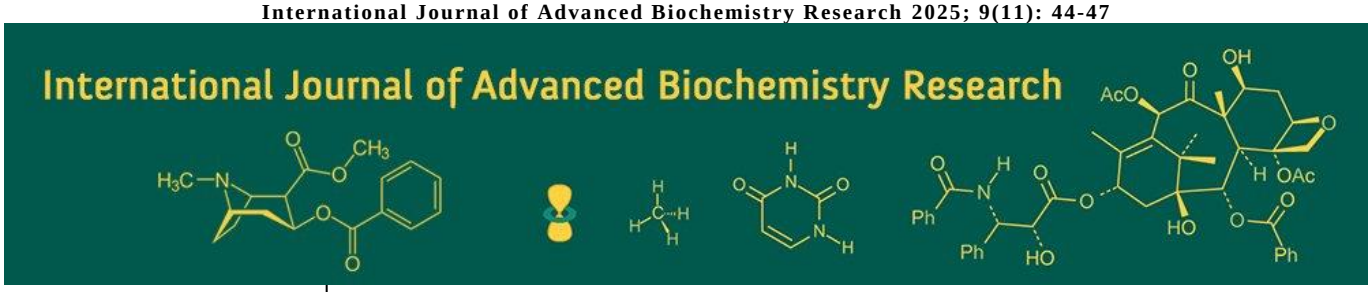

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Weed management in rice fallow sunflower under zero tillage in coastal Odisha

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Abstract
Field experiment was conducted during summer season of 2024 to study the effect of different weed management practices on weed growth and productivity of rice fallow sunflower (*Helianthus annuus* L.) under zero tillage condition in randomized block design with nine treatments replicated thrice. The treatments were, Glufosinate ammonium spray before sowing *fb* one intercultivation at 30 DAS, Glufosinate ammonium spray before sowing *fb* Pendimethalin 1.0 kg/ha as PE *fb* Quizalofop ethyl 05 EC 50 g/ha at 20 DAS as PoE, Pendimethalin 1.0 kg/ha as PE *fb* one intercultivation at 30DAS, Pendimethalin 1.0 kg/ha as PE *fb* Quizalofop ethyl 05 EC 50 g/ha at 20 DAS as PoE, Pendimethalin 1.0 kg/ha *fb* Propaquizafop 62 g/ha at 20 DAS as PoE, Two intercultivations at 20 and 40 DAS, One intercultivation at 20DAS *fb* one hand weeding at 30 DAS and Weed free (Three hand weedings at 15, 30 and 45 DAS), Unweeded control. The results revealed that, weed free treatment recorded highest WCE (90.35%) maximum seed yield (1943 kg ha^{-1}), oil yield (761kg ha^{-1}), net return (Rs.71154 ha^{-1}). However, Glufosinate ammonium spray before sowing *fb* Pendimethalin 1.0 kg/ha as PE *fb* Quizalofop ethyl 05 EC 50 g/ha at 20 DAS as PoE as directed post emergence spray recorded the highest B:C ratio (2.12) and recommended as an effective weed management method in rice fallow sunflower under zero tillage in coastal Odisha.

Keywords: Sunflower, weed management

1. Introduction
Sunflower (*Helianthus annuus* L.) which belongs to Asteraceae family, is the fourth important oilseed crop of the world after soybean, rapeseed and groundnut. It is a versatile crop which can be grown in any season of the year, but its performance is better in *rabi* or early summer sowings in odisha condition and its oil is rich in polyunsaturated fatty acid (PUFA). There are various factors responsible for low yield of sunflower; among them, weeds are the major threat resulting in a seed yield loss upto 45 to 55% (Wanjari *et al.*, 2001) [13]. Initially, the sunflower crop grows slowly, allowing weeds to multiply (Selvakumar *et al.*, 2018) [8] which compete with the crop for nutrients, moisture, light, and space, leading to reduced yields and diminished effectiveness of agricultural inputs (Suresh and Reddy, 2010). Heavy weed infestation in sunflower is mainly due to wider spacing, slower crop growth during early stages, higher fertilizers use and frequent irrigation. Manual weeding is difficult as it is highly labour intensive and time consuming. Herbicides are effective and viable option for weed management in sunflower (Shylaja and Sundari, 2008) [10]. Several pre-and post-emergence herbicides have been reported (Singh and Singh, 2006) [9] to provide a good degree of weed control but the information on their efficacy in rice fallow sunflower under zero tillage is inadequate. The application of herbicide once at pre-emergence stage may be inadequate in managing the whole spectrum of weeds of rice fallows. Sequential application of different herbicides ensures effective management (Tadavi *et al.*, 2017) [12] of composite weed flora of sunflower. Hence, the present experiment was conducted to find out an efficient weed management strategy for effective management of weeds and enhance productivity of paddy fallow sunflower.

2. Materials and Methods
A field experiment was carried out at Instructional Farm of Odisha University of Agriculture & Technology (OUAT), Bhubaneswar during summer season of 2024. The soil of the experimental field was sandy loam in texture, slightly acidic (pH-5.8), medium in organic

carbon (0.57%), medium in available nitrogen (171.4 kg ha-1), low in available phosphorous (22.0 kg ha-1) and medium in available potassium (91.5 kgha-1). During the crop growth period, total rainfall received (January to April) was 43.72mm with 14 rainy days. The mean maximum and minimum temperature observed was 34.3 degree Celcius and 22.4 degree Celcius respectively. The mean relative humidity ranged from 88% to 52%. The bright sunshine hours varied between 5.2 hrs/day. Hence, all the meteorological parameters prevailing during the crop growth period were satisfactory for growth and development of the crop. The experiment was laid out in randomized block design with nine treatments and three replications viz, T_1-Glufosinate ammonium spray before sowing *fb* one intercultivation at 30 DAS, T_2-Glufosinate ammonium spray before sowing *fb* Pendimethalin 1.0 kg/ha as PE *fb* Quizalofop ethyl 05 EC 50 g/ha at 20 DAS as PoE, T_3-Pendimethalin 1.0 kg/ha as PE *fb* one intercultivation at 30DAS, T_4-Pendimethalin 1.0 kg/ha as PE *fb* Quizalofop ethyl 05 EC 50 g/ha at 20 DAS as PoE, T_5-Pendimethalin 1.0 kg/ha *fb* Propaquizafop 62 g/ha at 20 DAS as PoE, T_6-Two intercultivations at 20 and 40 DAS, T_7-One intercultivation at 20DAS *fb* one hand weeding at 30 DAS and T_8-Weed free (Three hand weedings at 15, 30 and 45 DAS), T_9-Unweeded control. Dry weight of weeds was recorded at 60 DAS and at harvest. The weeds were uprooted from the destructive sampling area of one square metre and were oven dried at 70 °C for obtaining a constant weight and the dry weight of weeds was expressed in g m^{-2}. Weed control efficiency was calculated by the help of formula given by Mani *et al.* (1973) [4].

$$WCE = \frac{X-Y}{X} \times 100$$

Where, X: Weed dry matter production in weedy plot Y: Weed dry matter production in treated plot

Weed index indicates the extent of reduction in yield due to crop weed competition. It was worked out for different treatments by adopting the formula given by Gill and Kumar (1969) [2].

$$\text{Weed index} = \frac{A-B}{A} \times 100$$

Where A: Seed yield of the weed free treatment, B: Seed yield of the particular treatment for which the index is computed.

3. Results and Discussion

Weed density, weed control efficiency and weed index

Different weed management practices influenced weed density, weed control efficiency and weed index. At all the stages, the highest weed population and weed dry weight was recorded under unweeded check as compared to other treatments. While weed free treatment attained significantly lower weed population followed by One intercultivation at 20 DAS *fb* One hand weeding at 30 DAS. This may be due to the effectiveness of intercultural operations and hand weeding, which both reduced weed populations. The similar results were observed by Nagamani *et al.* (2011) [7]. The weed free (three-hand weeding at 15, 30 and 45 DAS) treatment had the lowest weed dry weight at harvest followed by one intercultivation at 20 DAS *fb* one hand weeding at 30 DAS. Similar findings were found by Kalaiyarasan and Vaiyapuri (2018) [3]. Weed control efficiency (WCE) was computed by taking into account total weed dry weight, which includes a range of weed species in different proportions, in order to prevent emphasising the effects of specific weed species. The weed free treatment in the current study indicated higher WCE (90.35%), because weeds were effectively controlled in a timely manner. The next best treatment was One intercultivation at 20 DAS *fb* One hand weeding at 30 DAS(84.14%) followed by Two intercultivations at 20 and 40 DAS(77.77%) followed by Glufosinate ammonium spray before sowing *fb* Pendimethalin 1.0 kg/ha as PE *fb* Quizalofop ethyl 05 EC 50 g/ha at 20 DAS as PoE (74.15%). This was attributed to lower weed population, which resulted in reduction of total dry weight of weeds in these treatments due to better control of weeds by cultural methods and imposition of herbicides. Similar findings were recorded by Mahapatra *et al.* (2024) [4, 5].

WI indicates the extent of yield reduction due to weed competition which indicated the suppressing effect of weed free check which had minimum weed competition and maximum seed yield. After weed free treatment, the lowest weed index was recorded in One intercultivation at 20 DAS *fb* one hand weeding at 30 DAS(5.28) followed by Glufosinate ammonium spray before sowing *fb* Pendimethalin 1.0 kg/ha as PE *fb* Quizalofop ethyl 05 EC 50 g/ha at 20 DAS as PoE(5.87). The lower value of weed index was due to lower weed infestation resulting in lower weed biomass production and higher yield. Similar results were found by Bharati *et al.* (2020) [1]. In unweeded control (weedy) plot the profuse weed growth restricted the vegetative growth and nutrient availability to the crop, there by caused the highest yield reduction. Similar reports were noticed by Mahapatra *et al.* (2024) [4, 5].

Growth, Yield attributes and yield

Effect on crop growth and yield

Weed free (three hand weeding at 15, 30 and 45 DAS) recorded maximum plant height (192 cm.) at harvest which remained at par with one intercultivation at 20DAS *fb* one hand weeding at 30DAS. The largest head diameter (17.2 cm) and 100 seed weight (5.53g) was observed in weed free (three hand weeding at 15,30 and 45 DAS). The seed yield varied significantly as a result of different weed management practices. The highest seed yield (1943 kg/ha) was observed in Weed free (three hand weeding at 15, 30 and 45 DAS) which is at par with One intercultivation at 20 DAS *fb* one hand weeding at 30 DAS (1860 kg/ha), Two intercultivation at 20 & 40 DAS (1840 kg/ha) and Glufosinate ammonium spray before sowing *fb* Pendimethalin 1.0 kg/ha as PE *fb* Quizalofop ethyl 05 EC 50 g/ha at 20 DAS as PoE(1829 kg/ha). The lowest seed yield (818 kg/ha) was recorded with control of highest removal of nutrients and moisture by weed and severe crop weed competition resulting in poor source-sink relationship with poor yield components. Similar type of results were also reported by Sumathi *et al.* (2009). The highest oil yield (761 kg/ha) was observed in Weed free (three hand weeding at 15, 30 and 45 DAS) which was at par with Two intercultivation at 20 & 40 DAS (732 kg/ha), One intercultivation at 20 DAS *fb* one hand weeding at 30 DAS (728 kg/ha), and Glufosinate ammonium spray before sowing *fb* Pendimethalin 1.0 kg/ha as PE *fb* Quizalofop ethyl 05 EC 50 g/ha at 20 DAS as PoE(714kg/ha). The

lowest oil yield (326 kg/ha) was recorded with control. Tadavi *et al.* (2017) [12] observed similar findings of highest oil yield with the weed free treatment.

Effect on economics

Weed free (three hand weedings at 15, 30 and 45 DAS) resulted in highest gross return (Rs.141450/ha) and net return (Rs.71154/ha) (Mahapatra *et al.*, 2024) [4, 5]. But the treatment, Glufosinate ammonium spray before sowing *fb* Pendimethalin 1.0 kg/ha as PE *fb* Quizalofop ethyl 05 EC 50 g/ha at 20 DAS as PoE resulted in highest BC ratio (2.12). Similar results were reported by Tadavi *et al.* (2017) [12].

Table 1: Effect of Weed management on weed population (no./m^2),weed dry weight(g/m^2), weed control efficiency(%) and weed index (%)

Treatment	Weed population (no./m^2)		Weed dry weight (g/m2)		Weed control Effeciency (%)		Weed index (%)
	30 DAS	60 DAS	60 DAS	Harvest	60 DAS	Harvest	
T_1-Glufosinate ammonium spray before sowing *fb* one intercultivation at 30 DAS	10.65 [112.95]	11.82 [139.27]	5.55 [30.44]	6.01 [35.57]	65.25	62.91	13.93
T_2-Glufosinate ammonium spray before sowing *fb* Pendimethalin 1.0 kg/ha as PE *fb* Quizalofop ethyl 05 EC 50 g/ha at 20 DAS as PoE	9.23 [84.73]	10.30 [105.51]	4.81 [22.66]	5.45 [29.34]	74.15	69.41	5.87
T_3-Pendimethalin 1.0 kg/ha as PE *fb* one intercultivation at 30DAS	9.88 [97.10]	10.88 [117.93]	5.17 [26.20]	5.75 [32.65]	70.08	65.96	11.88
T_4-Pendimethalin 1.0 kg/ha as PE *fb* Quizalofop ethyl 05 EC 50 g/ha at 20 DAS as PoE	11.83 [139.36]	12.89 [165.76]	5.98 [35.28]	6.47 [41.38]	59.75	56.86	17.16
T_5-Pendimethalin 1.0 kg/ha *fb* Propaquizafop 62 g/ha at 20 DAS as PoE	12.50 [155.57]	13.52 [182.40]	6.12 [37.00]	6.80 [45.77]	57.79	52.28	20.09
T_6-Two intercultivations at 20 and 40 DAS	8.70 [75.20]	9.77 [95.01]	4.46 [26.76]	5.22 [26.76]	77.77	72.1	5.28
T_7-One intercultivation at 20DAS *fb* one hand weeding at 30 DAS	8.03 [63.98]	9.29 [63.98]	3.79 [19.49]	4.49 [19.75]	84.14	79.41	4.25
T_8-Weed free (Three hand weedings at 15, 30 and 45 DAS)	6.59 [42.97]	7.84 [61.01]	2.99 [8.46]	3.66 [13.04]	90.35	86.41	-
T_9-Unweeded control	15.87 [251.3]	18.35 [336.45]	9.39 [87.66]	9.82 [95.92]	-	-	57.92
SEm(±)	0.141	0.138	0.128	0.175			
CD(p = 0.05)	0.42	0.41	0.38	0.53			

Table 2: Effect of weed management on yield attributes, yield and economics of sunflower

Treatment	Plant height (cm.)	Head diameter (cm.)	100 seed Wt. (g)	Seed yield (Kg/ha)	Oil yield (Kg/ha)	Gross return (Rs./ha)	Net Return (Rs./ha)	B: C ratio
T_1-Glufosinate ammonium spray before sowing *fb* one intercultivation at 30 DAS	167	15.7	4.90	1672	656	121748	57244	1.89
T_2-Glufosinate ammonium spray before sowing *fb* Pendimethalin 1.0 kg/ha as PE *fb* Quizalofop ethyl 05 EC 50 g/ha at 20 DAS as PoE	176	16.6	5.06	1829	714	133156	70368	2.12
T_3-Pendimethalin 1.0 kg/ha as PE *fb* one intercultivation at 30DAS	171	16.2	5.01	1712	670	124652	60892	1.96
T_4-Pendimethalin 1.0 kg/ha as PE *fb* Quizalofop ethyl 05 EC 50 g/ha at 20 DAS as PoE	166	15.3	4.81	1610	647	117185	56701	1.94
T_5-Pendimethalin 1.0 kg/ha *fb* Propaquizafop 62 g/ha at 20 DAS as PoE	158	15.0	4.60	1553	625	113037	52553	1.87
T_6-Two intercultivations at 20 and 40 DAS	182	16.7	5.27	1840	732	133985	68969	2.06
T_7-One intercultivation at 20DAS *fb* one hand weeding at 30 DAS	185	16.9	5.37	1860	728	135437	69717	2.06
T_8-Weed free (Three hand weedings at 15, 30 and 45 DAS)	192	17.2	5.53	1943	761	141450	71154	2.01
T_9-Unweeded control	124	9.6	4.52	818	326	59526	3310	1.06
SEm(±)	4.4	0.331	0.172	91.8	34.9	-	-	-
CD(p = 0.05)	13	0.99	0.52	275	105	-	-	-

4. Conclusion

It can be concluded that the weed free treatment in sunflower recorded maximum weed control efficiency, seed yield, gross and net return. But, considering the weed management practices, the treatment with Glufosinate ammonium spray before sowing *fb* Pendimethalin 1.0 kg/ha as PE *fb* Quizalofop ethyl 05 EC 50 g/ha at 20 DAS as PoE as directed post emergence on weeds registered better results compared to others. Hence, the weed free treatment (Three hand weeding at 15, 30 and 45 DAS) was followed by the treatment involving Glufosinate ammonium spray before sowing *fb* Pendimethalin 1.0 kg/ha as PE *fb* Quizalofop ethyl 05 EC 50 g/ha at 20 DAS as PoE as directed post emergence spray can be considered as the best treatment combination for getting higher yield with effective and economical weed management approach in rice-fallow sunflower under zero tillage in Odisha.

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