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Effect of weed management practices on growth and yield of *kharif* okra (*Abelmoschus esculentus* (L.) Moench)

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Abstract

A field experiment was conducted to study the response of *kharif* okra for different weed management practices at PG research block, College of Horticulture, (Sri Konda Laxman Telangana State Horticultural University) SKLTSHU, Rajendranagar, Hyderabad during the year 2019-20. The experiment was laid out in randomized block design with twelve treatments and replicated thrice. The weed management practices have significantly influenced the growth and yield contributing characters in *kharif* okra. Among the different weed management practices, black polythene sheet recorded the higher values for growth parameters such as plant height, leaf area, crop dry weight, no of branches, more no of nodes on main stem, pod yield per plant (345.2 g) and total pod yield (15.20 t ha⁻¹) when compared to other treatments. This was on par with mechanical weeding (inter row) followed by hand weeding (intra row) at 30 and 60 DAS (weed free check). The lowest values for growth and yield contributing were recorded with unweeded control plot. This study suggests that growing of okra under black polythene mulch gives higher yield.

Keywords: Okra, black polythene mulch, plant growth parameters, yield

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench] originated in Africa, belongs to the family Malvaceae, known as Lady's finger, having diploid chromosome no. $2n = 130$. Okra is one of the most important vegetables grown in tropical, sub tropical and warm temperate regions of the world. High iodine content of fruit helps control goitre while leaves are to inflammation and dysentery. Okra is one of the most nutritious vegetables which contains on an average of 1.9 g of protein, 0.2 g fat, 6.4 g carbohydrates, 0.7 g minerals, 1.2 g fiber per 100 g of edible portion (Gopalan *et al.* 1989). At present okra has good potential as a foreign exchange crop and accounts for 60 percent of the export of fresh vegetables. India is the largest producer of okra with an area of 513 000 ha and production of 6,170 thousand tonnes with the productivity of 12.0 mt ha⁻¹. In India, UP, Bihar and Orissa are major okra growing states. In Telangana, okra is grown in an area of 12,167 hectares, with production of 1,67,255 tonnes (NHB 2018-19). The crop can't tolerate weed competition due to its slow initial rate of growth and canopy coverage for effective shading. Weeds take advantage of moisture, soil fertility and environmental conditions to suppress the growth of crops. Weeds harbour for pests and diseases causing organisms, cause adverse allelopathic effects on okra and reduce the yield and quality of the produce. Due to this weed competition, the crop remains weak and unhealthy. Due to poor weed management practices in okra, yield losses varied from 40 - 80 percent (Sah *et al.* 2018) ^[23]. With this background, the present investigation was initiated to study the effect different weed management practices on growth and yield of *kharif* okra.

Materials and Methods

The present investigation was carried out at the PG research block of the department of Vegetable science, College of Horticulture, Rajendranagar, during *Kharif* - 2019. The experiment was laid out in Randomized block design with twelve treatments and replicated thrice.

The soil was sandy loam in texture, having 0.57% organic carbon, low in available nitrogen (192 kg ha⁻¹), phosphorus (5 kg ha⁻¹) and potassium (272 kg ha⁻¹) and slightly acidic reaction (pH 7.51), with normal electrical conductivity (0.22 dsm⁻¹). Twelve weed control treatments consisting of oxyfluorfen 0.2 kg ha⁻¹ (PE) + propaquizafop 62.5 g ha⁻¹ (PoE) + intercultivation at 45 DAS (T1), pendimethalin 675 g ha⁻¹ (PE) + propaquizafop 62.5 g ha⁻¹ (PoE) + intercultivation at 45 DAS (T2), oxadiargyl 90 g ha⁻¹ (PE) + propaquizafop 62.5 g ha⁻¹ (PoE) + intercultivation at 45 DAS (T3), oxyfluorfen 0.2 kg ha⁻¹ (PE) + rice straw mulch at 7-10 DAS (T4), pendimethalin 675 g ha⁻¹ + rice straw mulch at 7-10 DAS (T5), oxadiargyl 90 g ha⁻¹ + rice straw mulch at 7-10 DAS (T6), rice straw mulch at 7-10 DAS (T7), black polythene mulch (T8), stale seed bed + intercropping with green leafy vegetable (palak) (T9), mechanical weeding at 15, 30, 60 DAS (T10), mechanical weeding (inter row) followed by hand weeding (intra row) - (weed free check) (T11), unweeded control (T12). The seed of okra cv arka anamika was sown at 60 x 30 cm spacing. The field was fertilized with farm yard manure at the rate 25 t ha⁻¹ at the time of last ploughing and incorporated well into the soil. Ridges and furrows were formed at a spacing of 60 cm. The recommended basal dose of fertilizer at the rate of 40 kg ha⁻¹ nitrogen, 60 kg ha⁻¹ of phosphorus and 60 kg ha⁻¹ of potash was applied in the form of urea, single super phosphate and muriate of potash respectively and mixed with soil. Immediately after fertilizer application irrigation was provided. Thirty days after sowing, 40 kg of nitrogen per hectare was applied as top dressing and remaining 40 kg per hectare is applied at sixty days after sowing. Crop was sown on 23rd July 2019. Data were recorded on plant height, leaf area, crop dry weight, no of branches, no of nodes on main stem, days to initial flowering, days to 50% flowering, pod yield per plant and total pod yield by selecting five plants excluding border plants. Leaf area was computed at 30, 60, 90 DAS by using LI-COR LT-3000 portable leaf area meter with transparent belt conveyor with an electronic digital display and is expressed in cm². Total yield was calculated by adding total of 5 pickings at four days interval till final harvesting after 45 days after sowing.

Results and discussion Plant height (cm)

The effect of black polythene sheet on plant height was recorded in different stages i.e. 30, 60 and 90 DAS are presented in Table 1. The plant height increased with the advancement in crop age, irrespective of the treatment and reached maximum at harvest. The rate of increase in plant height was more at 30 to 60 DAS as compared to 60 DAS to harvest stage. At all the stages application of black polythene mulch sheet recorded the highest plant height and it was on par with mechanical weeding (inter row) followed by hand weeding (intra row) at 30 and 60 DAS (weed free check). The lowest plant height was recorded in unweeded control. Mulching with black polythene sheet recorded the highest plant height throughout the crop growth period. This may be due to better moisture conservation for plants under the mulch than hand weeding. It may also be attributed to better weed control as reported by Ritesh *et al.* (2018) [22]. Unweeded control plots recorded the lowest plant height throughout the crop period. Higher moisture stress resulting from transpiration on the weedy plots and especially the above and underground competitions from weeds may be responsible for poor height in unweeded plot. These results are similar to the results of Suresh *et al.* (2014) [27], Dalorima *et al.* (2014) [5],

Bhutia *et al.* (2017) [4], Manju *et al.* (2017) [16], Ritesh *et al.* (2018) [22], Shivaraj *et al.* (2018) [26], Laxmikanth *et al.* (2018) [14], Ashish *et al.* (2018) [11] and Nagegowda *et al.* (2019) [17].

Leaf area (cm²)

Statistically analyzed data pertaining to leaf area at different stages of crop growth is presented in Table 1. The leaf area increased from emergence and reached its peak at crop maturity. At all the three intervals, significantly the maximum leaf area was recorded in black polythene mulch it was on par with mechanical weeding (inter row) followed by hand weeding (intra row) at 30 and 60 DAS (weed free check). The minimum leaf area was recorded in unweeded control. These results were in line and agreement with the findings by Konyeha *et al.* (2013) [11]. Leaf abscission was observed to be greater on unweeded control. This could be attributed to the adverse effect of competition between okra plants and weeds. Okra plant could not absorb enough moisture and nutrient to sustain the leaves because moisture availability plays an important role in better nutrient uptake, higher photosynthetic efficiency which in turn results in better leaf size growth. Bagudo *et al.* (2016) [2], Shivaraj *et al.* (2018) [26] and Nagegowda *et al.* (2019) [17].

Dry matter production of crop (g m⁻²)

Weed management practices significantly influenced dry matter production of crop and the data recorded regarding dry matter production of crop at 30, 60, 90 DAS was given in Table 1 and Fig 1. At 30, 60 and 90 DAS, significantly the maximum dry matter accumulation was recorded in black polythene sheet and it was followed by mechanical weeding (inter row) followed by hand weeding (intra row) at 30 and 60 DAS (weed free check). The minimum dry matter accumulation was recorded in unweeded control. This might be due to soil moisture conservation was observed under black polythene sheet. The improvement in growth characters as a result of using mulches might be due to the enhancement in photosynthesis and other metabolic activities (Bhatt *et al.* 2011 and Parmar *et al.* 2013) [3, 20]. Mulches benefit the plant growth by conserving soil structure and acting as a barrier to the rainfall which causes soil compaction and soil erosion. Less-compacted soil provides a better environment for seedling emergence and root growth (Kumar & Dey, 2011) [12]. The better root growth is also because plastic mulch creates a salt free zone around the plant root system, encouraging better growth, which has positively reflected on vegetative and yield parameters. Similar findings were also reported by Gordon *et al.* (2010) [7], Hamid *et al.* (2012) [8], Ogbomo *et al.* (2013) [13], Bhutia *et al.* (2017) [4] and Patel *et al.* (2017) [21].

Number of branches per plant

The statistically analyzed data regarding no of branches is presented in Table At 30 DAS, branches were not found but at 60 DAS, the highest no of branches were recorded in black polythene sheet mulch and it was on par with mechanical weeding (inter row) followed by hand weeding (intra row) at 30 and 60 DAS (weed free check). The lowest no of branches were recorded in unweeded control. In general, the number of branches increased from 30 DAS to 90 DAS. Higher number of branches under black polythene might be due to better moisture conservation for plants under the mulch than hand weeding. Conversely, the lowest number of branches were noticed in unweeded control. Severe infestation of weeds might have reduced the vegetative growth of plants. Higher

moisture stress resulting from transpiration on the weedy plots and especially the above and underground competitions from weeds may be responsible for poor okra growth on all the time weedy plot. These results were similar to Suresh *et al.* (2014)^[27], Dalorima *et al.* (2014)^[5], Bhutia *et al.* (2017)^[4], Manju *et al.* (2017)^[16], Shivaraj *et al.* (2018)^[26], Laxmikanth *et al.* (2018)^[14], Ashish *et al.* (2018)^[1] and Nagegowda *et al.* (2019)^[17].

Number of nodes on main stem per plant

No of nodes were significantly influenced by various weed control practices and the data pertaining to no of nodes at different stages of crop growth is presented in Table 1. At 30, 60 and 90 DAS, significantly the highest no of nodes on main stem were recorded in black polythene sheet mulch it was on par with mechanical weeding (inter row) followed by hand weeding (intra row) at 30 and 60 DAS (weed free check). The lowest no of nodes were recorded in unweeded control. This might be due to better moisture conservation for plants under the mulch than under hand weeding. Unweeded control plots recorded the lowest no of nodes throughout the crop period. Higher moisture stress resulting from transpiration on the weedy plots and especially the above and underground competitions from weeds may be responsible for poor no of nodes in weedy plot. Our findings were supported by Bhutia *et al.* (2014)^[4], Patel *et al.* (2017)^[21] and Shivaraj *et al.* (2018)^[26].

Number of days to initial flowering and 50% flowering

The data pertaining to the days taken to initial and 50 % flowering as per visual observations made was presented in Table 2. The data indicated that the crop had taken about 36 days for initial flowering and 39 days for 50 per cent flowering in black polythene sheet mulch which was on par with mechanical weeding (inter row) followed by hand weeding (intra row) at 30 and 60 DAS (weed free check) at 39 and 41 DAS respectively. Initial and 50% flowering was delayed in unweeded control 48 and 52 DAS respectively. The earliness in crop maturity under black polythene, might be related with the increased accumulated soil temperature under polythene film mulch. The earliness in flowering can also be attributed to simultaneous transport of growth substances like cytokinin to the auxillary bud breaking the apical dominance. Hazarika and Ansari, 2010^[9], Ogbomo *et al.* (2013)^[13] and Nagegowda *et al.* (2019)^[17].

Pod characters

The data pertaining to the pod characters (pod length, diameter and weight) were presented in Table 2. Significantly maximum pod length, diameter and weight were recorded in black polythene sheet mulch treatment which was on par with mechanical weeding (inter row) followed by hand weeding (intra row) at 30 and 60 DAS (weed free check). The minimum pod length was recorded in unweeded control. Black plastic mulch enhanced better plant growth, which facilitated in accumulation of more photosynthates and conservation of optimum temperature resulting in increased

size and weight of fruits. Similar results were found by Shivaraj *et al.* (2018)^[26]. Growth is the function of photosynthetic activity of the okra plant and their capacity to utilize available nutrients. Thus enhanced availability of nutrients, water, light and space resulted in increase in plant height, number of leaves and dry matter accumulation which reflected in term of higher pod length, pod diameter and average pod weight. These findings were supported by Pandey and Mishra (2013)^[19], Ogbomo *et al.* (2013)^[13], Shivalingappa *et al.* (2014)^[25], Jalendhar *et al.* (2016) and Patel *et al.* (2017)^[21].

Pod yield

Pod yield contributing characters like number of pods per plant, pod yield per plant and total pod yield were significantly influenced by various weed management practices and the data is given in Table 2.

Number of Pods per plant

Highest number of pods per plant recorded with black polythene sheet mulch (23.81) it was on par with mechanical weeding (inter row) followed by hand weeding (intra row) at 30 and 60 DAS (weed free check) (22.89). The minimum number of pods per plant recorded in unweeded control (7.89). Similar results were reported by Suresh *et al.* (2014)^[27], Dalorima *et al.* (2014)^[5], Bhutia *et al.* (2017)^[4], Shivaraj *et al.* (2018)^[26], Laxmikanth *et al.* (2018)^[14], Ashish *et al.* (2018)^[1] and Nagegowda *et al.* (2019)^[17].

Pod yield per plant (g plant-1)

Pod yield per plant was significantly highest in black polythene sheet mulch treatment (345.2) which was followed by mechanical weeding (inter row) followed by hand weeding (intra row) at 30 and 60 DAS (weed free check) (298.3). The least pod yield per plant was recorded in unweeded control (83.5).

Total pod yield (t ha-1)

Maximum pod yield was recorded in black polythene sheet mulch treatment (15.20) which was on par with mechanical weeding (inter row) followed by hand weeding (intra row) at 30 and 60 DAS (weed free check) (14.93). The least total pod yield was recorded in unweeded control (4.09). Higher yield of okra obtained with the black polythene mulching, might be due to direct effect of improved soil nutrients, structure and moisture content and reduced weed pressure. The solarization effect of plastic mulch makes for higher nutrient availability results in higher yields. Mahadeen (2014) also have reported positive effect of black polythene sheet mulching on yield of okra. Reduced pod yield in case of unweeded control might be due to reduced plant growth, reduced fruit size and number and due to severe crop weed competition for nutrients, moisture, light and space during the crop growth period. Similar results were reported by Sathya *et al.* (2013)^[24], Jalendhar *et al.* (2016)^[10], Bhutia *et al.* (2017)^[4], Ritesh *et al.* (2018)^[22] and Nagegowda *et al.* (2019)^[17].

Table 1: Influence of weed management practices (cm), Leaf area (cm²), dry matter production (g m⁻²), no of branches and no of nodes per main stem

Treatment		Plant height (cm)			Leaf area (cm ²)			Dry matter production (g m ²)			No of branches			No of nodes per main stem		
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T1	Oxyfluorfen 23.5% EC 0.2 kg ha-1 (PE) fb propaquizafop 10% EC 62.5 g ha-1 at 2-3 leaf stage (PoE) fb intercultivation at 45 DAS.	17.15c	59.95e	97.01cd	21.83gh	91.67g	941.65e	6.95d	205.30c	320.10f	1.43ef	3.22cd	1.43ef	2.80de	6.07de	14.00d
T2	Pendimethalin 38.7% CS 675 g ha-1 (PE) fb propaquizafop 10% EC 62.5 g ha-1 at 2-3 leaf stage (PoE) fb intercultivation at 45 DAS.	19.78c	76.20c	111.11bc	34.03fg	177.89b	1114.63d	7.55c	176.61e	341.15d	2.40cd	4.22b	2.40cd	3.47cd	8.00cd	14.55d
T3	Oxadiargyl 80% WP 90 g ha-1 (PE) fb propaquizafop 10% EC 62.5 g ha-1 at 2-3 leaf stage (PoE) fb intercultivation at 45 DAS.	18.56c	72.81cd	105.58c	41.28e	129.72ef	1139.43d	7.62c	189.56d	340.83d	2.17d	4.99b	2.17d	3.53c	10.13b	14.00d
T4	Oxyfluorfen 23.5% EC 0.2 kg ha-1 (PE) followed by rice straw mulch (5t ha-1) at 7-10 DAS.	16.80cd	62.84de	119.11b	25.05g	94.53g	1288.11c	6.09e	186.77de	319.66f	1.67e	4.11bc	1.67e	4.33bc	9.33b	18.33bc
T5	Pendimethalin 38.7% CS 675 g ha-1 fb rice straw mulch (5t ha-1) at 7-10 DAS.	24.12b	82.87b	122.08b	53.18cd	144.92d	1467.55b	6.67de	191.54d	333.64e	2.67c	4.55b	2.67c	4.67b	10.40b	17.33c
T6	Oxadiargyl 80% WP 90 g ha-1 fb rice straw mulch (5t ha-1) at 7-10 DAS	23.00b	82.19bc	122.40b	48.07d	151.92cd	1444.92b	6.75d	193.19d	343.55d	2.77c	4.99b	2.77c	4.60b	10.53b	18.77b
T7	Rice straw mulch at 7-10 DAS (5t ha-1).	23.63b	83.27b	117.81b	52.70cd	146.38d	1479.38b	7.56c	187.47d	402.92c	3.60b	4.29b	3.60b	4.40b	10.67b	17.11c
T8	Black polythene mulch.	33.74a	94.75a	131.35a	126.90a	224.74a	1549.22a	11.94a	240.64a	545.63b	4.21a	6.03a	4.21a	5.80a	12.74a	21.55a
T9	Stale seed bed followed by inter cropping with green leafy vegetable (palak).	22.66bc	77.75c	118.98b	34.56f	163.12bc	1166.24d	7.84c	210.60bc	405.03c	2.67c	4.11bc	2.67c	4.13c	9.53b	14.89d
T10	Mechanical weeding at 15, 30, 60 DAS.	23.71b	68.66d	119.07b	58.38c	126.75f	1113.93d	7.30cd	220.88b	401.67c	2.53c	4.67b	2.53c	4.33b	9.07bc	14.33d
T11	Mechanical weeding (inter row) followed by hand weeding (intra row) at 30 and 60 DAS - (weed free check).	30.72a	88.76ab	125.64ab	79.91b	143.99de	1495.56ab	10.51b	238.65a	565.43a	4.07a	5.29ab	4.07a	5.30ab	10.97ab	20.00ab
T12	Unweeded Control	14.45d	37.93f	65.11d	18.73h	90.55g	769.39f	4.65f	135.58f	238.54g	1.12f	2.37d	1.12f	2.23e	5.67e	10.55e
SE (m)±		1.03	2.26	4.09	2.14	4.84	23.34	0.21	3.80	1.65	0.13	0.31	0.13	0.35	0.67	0.67
CD at 5%		3.02	6.62	12.00	6.30	14.20	68.46	0.63	11.14	4.95	0.39	0.91	0.39	1.03	1.97	1.98

Table 2: Influence of weed management practices on number of days to flowering, pod characters and yield

Treatment		Initial flowering	50% flowering	Pod length (cm)	Pod diameter (cm)	Pod weight (g)	No. of pods per plant (no)	Pod yield per plant (g)	Total Pod yield (t ha-1)
T1	Oxyfluorfen 23.5% EC 0.2 kg ha-1 (PE) fb propaquizafop 10% EC 62.5 g ha-1 at 2-3 leaf stage (PoE) fb intercultivation at 45 DAS.	44.31cd	49.44c	11.24b	1.22d	9.98c	9.89d	161.5de	5.32ef
T2	Pendimethalin 38.7% CS 675 g ha-1 (PE) fb propaquizafop 10% EC 62.5 g ha-1 at 2-3 leaf stage (PoE) fb intercultivation at 45 DAS.	41.48b	45.62b	11.71b	1.26d	10.44b	14.22c	183.7d	11.29b
T3	Oxadiargyl 80% WP 90 g ha-1 (PE) fb propaquizafop 10% EC 62.5 g ha-1 at 2-3 leaf stage (PoE) fb intercultivation at 45 DAS.	41.91bc	45.71b	11.13b	1.43c	10.51b	14.67c	187.7cd	10.41b
T4	Oxyfluorfen 23.5% EC 0.2 kg ha-1 (PE) followed by rice straw mulch (5t ha-1) at 7-10 DAS.	47.10d	50.40c	10.90b	1.32cd	9.34c	10.00d	134.1e	5.58e
T5	Pendimethalin 38.7% CS 675 g ha-1 fb rice straw mulch (5t ha-1) at 7-10 DAS.	39.56b	41.87a	11.67ab	1.53c	10.90b	14.33c	198.1c	9.59cd
T6	Oxadiargyl 80% WP 90 g ha-1 fb rice straw mulch (5t ha-1) at 7-10 DAS	39.64b	41.90a	11.17b	1.27d	10.80b	16.67b	201.7c	9.78c
T7	Rice straw mulch at 7-10 DAS (5t ha-1).	39.90b	42.34ab	11.44b	1.67b	10.14c	18.44b	218.1c	11.75b
T8	Black polythene mulch.	35.67a	39.23a	12.74a	2.58a	12.90a	23.81a	345.2a	15.20a
T9	Stale seed bed followed by inter cropping with green leafy vegetable (palak).	42.55c	44.52b	10.85bc	1.35c	10.35b	14.77c	164.6d	8.22d

T10	Mechanical weeding at 15, 30, 60 DAS.	43.95c	45.74bc	10.98b	1.51c	10.34bc	14.67c	176.5d	9.14d
T11	Mechanical weeding (inter row) followed by hand weeding (intra row) at 30 and 60 DAS - (weed free check).	38.62ab	41.13a	12.11ab	2.32ab	11.88ab	22.89a	298.3b	14.93a
T12	Unweeded Control	48.26d	52.09c	9.45c	0.84e	7.98d	7.89e	83.5f	4.09f
SE (m)±		1.31	1.41	0.40	0.13	0.56	0.61	10.58	0.50
CD at 5%		3.84	4.12	1.16	0.37	1.64	1.79	31.04	1.46

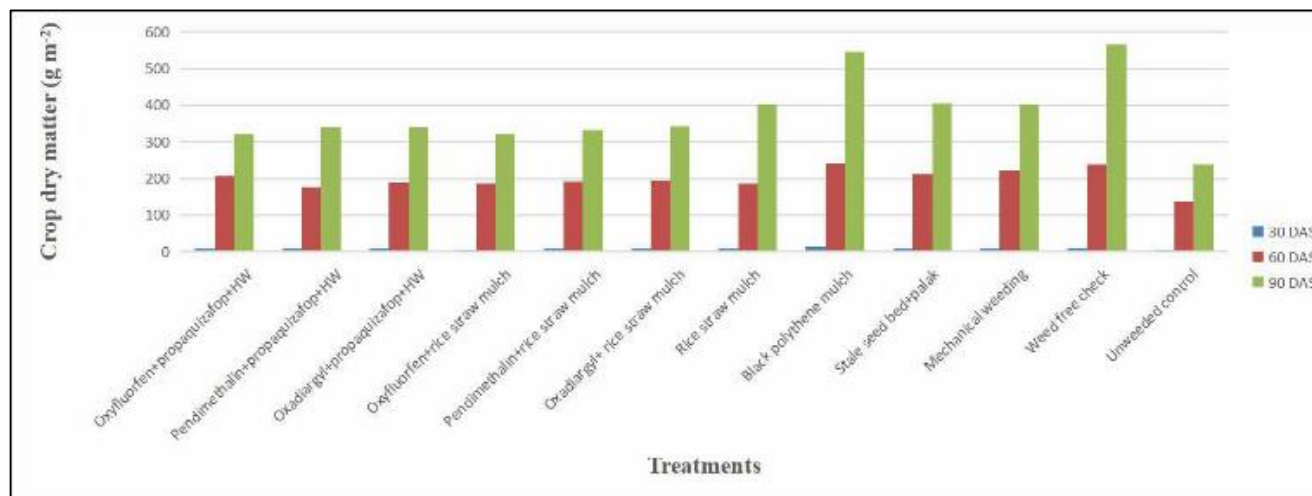


Fig 1: Influence of weed management practices on crop dry matter (g m⁻²)

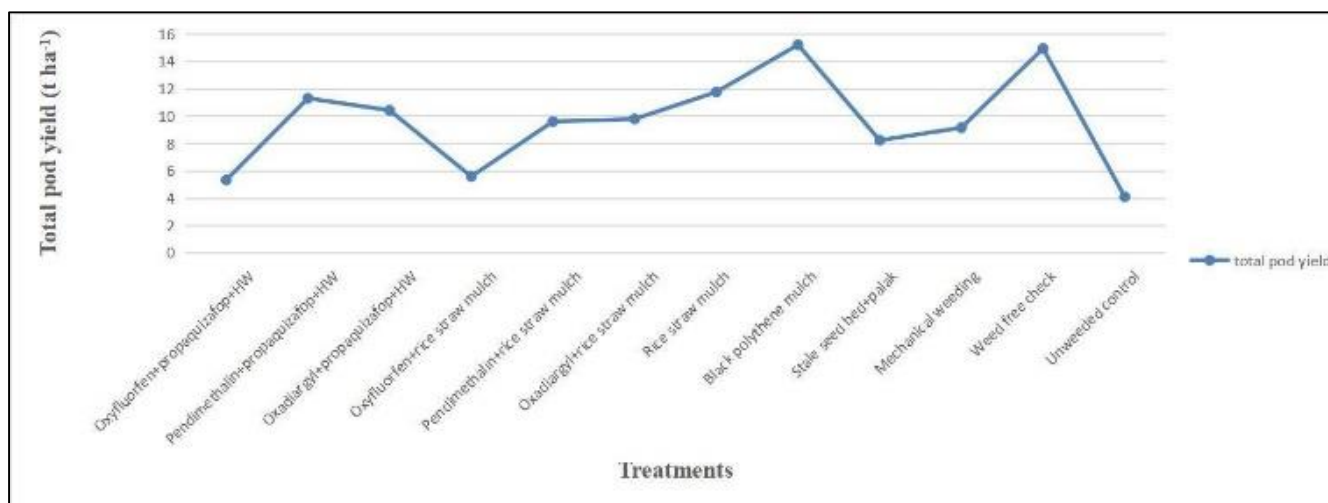


Fig 2: Influence of weed management practices on total pod yield (t ha⁻¹)

Conclusion

The study concluded that black polythene mulch enhanced better plant growth which facilitated in accumulation of more photosynthates and conservation of optimum temperature resulting in increased size and weight which further improved the yield. Higher values were recorded with black polythene sheet mulch and it was followed by weed free check. Plant height, leaf area, no of branches, no of nodes on main stem per plant and the crop dry matter production were the highest in black polythene sheet mulch and it was on par with weed free check. Days to initial and 50 per cent flowering was advanced significantly by 2-4 days in unweeded control due to heavy weed infestation over the other treatments. The yields were inversely related to weed infestation. The highest yield (15.20 t ha⁻¹) was obtained with black polythene sheet mulch which was on par with weed free check (14.93 t ha⁻¹). Due to heavy weed infestation in unweeded control recorded very low yield of 4.09 t ha⁻¹.

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