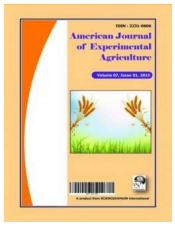

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Weed Dynamics in Greengram as Influenced by Mulching and Weed Management Practices under Eight Year Old Custard Apple Plantation in Agri-horticultural System

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted at Agronomy Research Station, Barkacha, Mirjapur 2013-14 in order to control greengram associated weed under Custard apple plantation during *Kharif* season. The basic objective of the study was to assess the effect of mulching and weed management practices on weed dynamics and greengram yield under agri- horticultural system. Three mulch treatments taken in main plots (no-mulching, dust-mulching and paddy straw-mulching) and five weed control treatments (weedy check, weed free, pendimethalin pre-emergence (PE) 1000 g ha^{-1}, imazethapyr post-emergence (PoE) 100 g ha^{-1} and pendimethalin (PE) 1000 g ha^{-1}+ imazethapyr (PoE) 100 g ha^{-1}) was randomly allocated to subplots and these were replicated thrice in split plot design on

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sandy clay loam soils with pH 6.2. The various weeds observed in greengram field were *Cyperus rotundus*, *Echinochloa colona*, *Cynodon dactylon* and *Erogrostis pilosa*. Among the grasses, *Echinochloa colona*, in broad leaved weed *Erogrostis pilosa* and in the sedges *Cyperus rotundus* was predominant. Dust mulching recorded significantly the highest grain yield (747 kg ha^{-1}), straw yield (1797 kg ha^{-1}) and lowest weed index (1.44%), density and dry weight of *Cyperus rotundus*, *Echinochloa colona*, *Cynodon dactylon* and *Erogrostis pilosa*, as well as total density and dry weight of weeds over paddy straw mulching. Among herbicidal treatments, sequential application of pendimethalin (1000 g ha^{-1}, PE) + imazethapyr (100 g ha^{-1}, PoE) resulted lower density and dry weight of *Cyperus rotundus*, *Echinochloa colona*, *Cynodon dactylon* and *Erogrostis pilosa* as well as total density and dry weight of weeds, and recorded significantly highest grain yield (726 kg ha^{-1}) and straw yield (1726 kg ha^{-1}) with minimum weed index (4.15%) followed by same was with the alone application of pendimethalin and imazethapyr, respectively. Weed control efficiency and the regression of yield on it revealed that 1% increase in the weed control efficiency increased the grain yield by 1.873 kg ha^{-1} and in the straw yield by 2.085 kg ha^{-1}. It is concluded that dust mulching and sequential application of pendimethalin (1000 g ha^{-1}, PE) + imazethapyr (100 g ha^{-1}, PoE) resulted significantly the highest grain and straw yield; and lowest weed index (1.44%), density and dry weight of weeds over other weed management treatments.

Keywords: Custard apple; greengram; herbicides; mulching; weed; yield.

1. INTRODUCTION

Pulses are the important source of protein for human nutrition. The per capita availability of pulses has progressively declined in the country from its peak of 66 g $day^{-1}capita^{-1}$ during 1950's to 32 g $day^{-1}capita^{-1}$ at present which is less than the recommended (50 g $day^{-1}capita^{-1}$) dietary allowance [1]. Supply of pulses falls short of their total demand and therefore the demand-supply gap is met by imports. The pressure on prices is due to lower domestic availability of these commodities, and thus, the focus should be on managing their supplies through increased production and/or imports, depending upon India's comparative advantage. Total pulse production in India during 2011-12 is estimated to be 17.21 million tonnes from the area of 24.78 million hectares with the average productivity 694 kg ha^{-1} [2].

Greengram [*Vigna radiata* (L.) R. Wilczek] is one of the most widely cultivated pulse crops in the country and is grown on about 3.44 Mha with the annual production of 1.78 Mt along with the productivity of 499 kg ha^{-1} [2]). Greengram grown in different seasons and cropping systems due to its wider adoptability and less sensitivity to photoperiod and thermal variations [3,4]. Cultivation of greengram during summer is receiving wider acceptance with the availability of new varieties for additional income, improvement in soil fertility, and efficient land utilization [5]. The conventional rainy season crop is affected due to aberrant weather conditions and its greater vulnerability to weeds [6] and other insect-pests and diseases. Growth behaviour of this crop differs in different seasons due to variation in temperature, photoperiod, humidity etc. [7]. Its initial growth rate is relatively slow and consequently weeds have a smothering effect on crop plants and compete for moisture, space, nutrient and light [8]. In environmental production and ecological farming, there is increasing interest in herbicide free weed control. Mulching is one of the possible ways to control weeds without using herbicides [9].

Besides this it also reduce soil erosion, evaporation suppressant, increasing infiltration and population of beneficial micro-organisms [10], improve soil moisture status, nutrient utilization, disease control, soil temperature regulation and can suppress weeds, due to delayed emergence and smothering effect on weeds [11,12]. Applications of 10 tons of rice or wheat straw as mulch in summer greengram reduces emergence and growth of weeds and have a favourable effect on yield [8]. Newspaper mulching significantly reduces density and dry weight of weeds in pea over polythene, wheat straw and dust mulching [13,14]. Moreover, straw mulch incorporated into the soil can add a fair amount of nutrients and improve the physico-chemical properties of the soil. By virtue of being a restorer of soil fertility, pulses have a unique position in the cropping system, particularly in dry land or rainfed agriculture [15].

Agri-horticultural system markedly increases the return per unit of land mainly during early stage of horticultural fruit trees. Fruit tree based agro

forestry involves intentional and simultaneous association of annual or perennial crops with perennial fruit-producing trees on the same land unit. The relatively short juvenile (pre-production) phase of fruit trees, high market value of products and the contribution of fruits to household dietary needs, fruit-tree-based agro forestry enjoy high popularity among producers worldwide. In *Vindhyan* region of Uttar Pradesh growing of pulses, intercropped with custard apple, guava, bael, *subabool*, and *Kronda* etc., are more suitable under the agri-horticultural system, recorded lower density and dry weight of weeds [16,17]. Greengram is an important legume is widely cultivated in various climate and geographical regions of India [18]. It is a viable option as an intercrop in the alleys of agri-horticultural plantation and provides extra income, improves the fertility of the soil, enabling the main crop to give a better yield compared with the sole crop of sugarcane/banana/tapioca [19]. It is a short duration crop needs more attention on weed control. Weeds grow more vigorously and pose as serious threat to its cultivation. Being a rainy season crop, it is heavily infested by a large number of fast growing weeds, especially during the critical period of crop-weed competition. Thus, reduces the yield of greengram by 42-64 percent [20].

Often 2-3 hand weeding is required to keep the greengram weed free [21]. Manual weeding is costly because it is not only time consuming but labour intensive also [21]. However, its additional advantage of providing greater aeration and soil moisture conservation cannot be ignored. But, with the increasing crisis of labour, exploring the possibility of herbicidal weed control in greengram deserves attention [22]. Nowadays herbicide is an integral part of intensive agriculture throughout the world. Herbicide not only save valuable time and money but also allow coverage of more area in short period in carrying out weeding timely. But indiscriminate use of herbicides is posing environmental threats. Allelopathic interaction between plants and other organisms have been recognized by scientists worldwide because they offer alternative remedies in agriculture such as decreasing reliance on synthetic herbicides, insecticides and fungicides for weed, insect and disease control [23].

Greater knowledge of compatible agro-forestry species greatly facilitates formulation of agro-forestry systems with higher yields. Simultaneously, influence of weed management practices on weeds and crops would generate a better understanding to improve crop-weed competition [16]. Knowledge regarding these important issues may help in executing 'cautious' and 'opportunistic' weed management and improving yield of greengram. However, the information on comparative performance of mulching and weed management practices in greengram on weeds under agri- horticultural system is lacking.

Keeping above facts in mind the present investigation was carried out with following objectives: To study the effect of mulching and weed management practices on weed dynamics and to study the effect of mulching and weed management practices on greengram yield under agri- horticultural system.

2. MATERIALS AND METHODS

2.1 Experimental Site

A field study was conducted during the winter seasons of 2012-13 at at south campus, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh, India during the kharif seasons of 2013-14. The experimental site is located at 85° east longitude and 25° north latitude and at an altitude of 365 meters above mean sea level.

2.2 Soil

The experimental soil was sandy clay loam with pH 6.2. The soil was low in available N [24] 176.2 kg ha^{-1}, medium in available P [25] 11.2 kg ha^{-1} and high in available K [26] 184.5 kg ha^{-1}. The experiment was conducted in split plot design having 15 treatments with 3 replications. Field capacity (7.9 percent), permanent wilting point (1.8 percent) and bulk density (1.53 Mg m^{-3}) were recorded in 0-30 cm soil depth.

2.3 Climatic

Experimental site falls in a belt of semi-arid to sub-humid climate. The normal period for the onset of monsoon in this region is the third week of June and it lasts up to end of September or sometimes extends to the first week of October. Winter showers are often experienced in between the month of December to mid of February. However, March to May is generally dry. On an average, out of the total annual rainfall major fraction (75 percent) is received from June to September. The winter months are

cool whereas summers are hot and dry. The coldest and hottest month is January and May, respectively. The temperature begins to rise from the month of February and reaches its maximum in May.

During the crop season total rainfall received was 746.11 mm. Out of total rainfall more than 88 per cent received between 30 to 35 standards meteorological weeks (SMW). Data showed that there was very less fluctuations in maximum temperature. The mean maximum temperature during the crop growth season is 35.44℃ whereas; mean minimum temperature is 25.67℃. The average weekly temperature was lowest (32.92℃) in 35 meteorological week and maximum (35.44℃) in 30 th meteorological week. The relative humidity varied between 90 per cent and 96.57% and evaporation range between 2 to 5.4 mm. Climatic data of the experiment are shown in Table 1.

2.4 Cultural Practices

The greengram 'HUM- 16' was sown on 19th July 2013 with the help of manual single row drill at 30.0 cm row spacing using 20 kg seed ha^{-1} in 4.0 x4.5m^2 gross plot size under the eight year old custard apple (*Annona squamosa* L.) plantation. Custard apple is one of the delicious and nutritious fruits can be grown in areas with rainfall as low as 400 mm. It was probably introduced into Australia from British Guiana. It is erect, with a rounded or spreading crown and trunk 10 to 14 inches (25-35 cm) thick. Height of the tree ranges from 15 to 35 feet (4.5-10 m). The custard apple was planted in 2005-2006 with spacing 5×5 m^2, the detail dimensions of fruit tree during experimentation are presented in Table 3. Fertilizer was applied 20- 60-40 NPK kg ha^{-1} in the form of Urea, Single Super Phosphate and Murate of Potash, respectively. All the nitrogen, phosphorous and potash were applied at the time of sowing. Herbicides was applied in respective treatment combinations with the help of flat fan nozzle attached to the foot sprayer using volume of spray 500 litters/ha. All agronomic and cultural operations were followed for the success the crop.

2.5 Statistics

The experiment was laid out in a split plot design using three mulch treatments viz., M_{1-} no mulch, M_{2-} dust mulch (manipulation of soil with *Khurpi* (Spud) after the occurrence of rainfall when soil condition is appropriate) and M_3- paddy straw mulch (6 tones ha^{-1} after the emergence of crop plant at 7th day) were assigned as main-plots, whereas five weed control treatments viz. W_{1-} weedy check, W_{2-} weed free (HW at 20 and 40 DAS), W_{3-} pendimethalin pre-emergence (PE) 1000 g ha^{-1}, W_{4-} imazethapyr post-emergence (PoE) 100 g ha^{-1} and W_{5-} pendimethalin (PE) 1000 g/ha + imazethapyr (PoE) 100 g/ha was randomly allocated to subplots.

Data on density and dry weight of weed was recorded from an area enclosed in the quadrate of 0.25 m^2 randomly selected at three places in each plot.

Table 1. Mean week-wise meteorological data during crop season rainy (*kharif*) 2013

Week no.	Month and date	Rainfall (mm)	Temperature (℃)		Relative humidity (%)		Evaporation (mm)
			Max.	Min.	Max.	Min.	
28	8-14 July	60.59	34.19	26.29	90	85	2
29	15-21 July	00	35.25	27.78	91.33	81	2.4
30	22-28 July	105.29	35.44	26.90	92.60	78	3.4
31	29 July-4 Aug.	107.64	33.52	26.66	94.83	82	5.4
32	5-11 Aug.	32.35	34.11	26.55	95.50	81	3.4
33	12-18 Aug.	78.22	33.35	26.23	94.14	79	3
34	19-25 Aug.	149.93	33.34	26.21	96.57	88	2.7
35	26Aug.-2 Sep.	186.80	32.92	26.02	92.57	85	2.6
36	3-8 Sep.	00	34.34	25.67	92.10	79	3.6
37	9-15 Sep.	25.29	34.58	25.91	91.22	80	2.9
38	15 Sep. – 22 Sep.	00	35.45	24.82	90.12	79	2.8

Oven dry weight of weeds was recorded at 70℃ for 48 h. and expressed as dry matter g m^{-2}. The plants from each net plot were harvested on 18th September 2013 separately and stacked plot wise for sun drying and subsequent threshing. The mean density and biomass of weeds were square root transformed (√x+0.5) to normalize the count data and analyzed statistically as per the standard analysis of variance to draw valid conclusions [27].

3. RESULTS AND DISCUSSION

3.1 Crop and Weather

Results are affected by prevailing weather conditions during experimentation. Greengram is basically a crop of wormer region of the sub tropics. The overall performance of the crop was normal. The possible reasons would appear to be related to favourable weather condition during the *kharif* season of 2013-14 are presented in Table 1. During the crop season total rainfall received was 746.11 mm. Out of total rainfall more than 88 per cent received between 30 to 35 Standard Meteorological Weeks (SMW). Data showed that there was very less fluctuations in maximum temperature. The mean maximum temperature during the crop growth season is 35.44℃ whereas; mean minimum temperature is 24.82℃. The average weekly temperature was lowest (32.92℃) in 35th meteorological week and maximum (35.44℃) in 30nd meteorological week. Maximum and minimum temperature was favourable for the growth and development of crop. The relative humidity varied between 90 per cent and 96.57% and evaporation range between 2 to 5.4 mm. Results corroborated with the research findings of [7].

3.2 Relative Frequency of Weed Flora

The important weed flora and their relative composition was recorded at 40 DAS in weedy check plot revealed that weed flora of experimental field consists of narrow, broad leaved weeds and sedge in order of dominance (Table 2). The important weed species in control plots were *Cyperus rotundus* L. (26.4%), Echinochloa *colona* L. (25.8%), *Cynodon dactylon* Pers (24.7%) and *Erogrostis pilosa* L. (23.1%) accounted for total weed species. These are the most dominated weed in greengram [8,21,28].

3.3 Impacts on *Cynodon dactylon*

Density and dry matter accumulation by *Cynodon dactylon* in all the weed management treatments including two hand weeding (weed free) at 20 and 40 DAS reduced than weedy check (Figs. 1, 1a). Dust mulching recorded the lowest density (9.6 m^{-2}) and dry weight (0.74 g m^{-2}) of *Cynodon dactylon* followed by the density and dry weight with paddy straw mulching and no-mulching. It is a creeping perennial and sometimes emerged even after the application of herbicides also but straw mulching successfully restricts its emergence [9]. Among the herbicidal treatments, sequential application of pendimethalin (1000 g ha^{-1}, PE) + imazethapyr (100 g ha^{-1}, PoE) resulted lower density (9.33 m^{-2}) and dry weight (1.05 g m^{-2}) of *Cynodon dactylon* followed by pendimethalin (1000 g ha^{-1}, PE) and imazethapyr (100 g $^{-1}$ha, PoE), respectively.

3.4 Impacts on *Cyperus rotundus*

Among mulching, dust mulching resulted significantly the lowest density (8.0/m^2) and dry weight (0.66 g m^{-2}) of *Cyperus rotundus* over paddy straw mulching and highest under no-mulching (Figs. 2, 2a). All the herbicidal treatments were superior to unweeded check in controlling *Cyperus* at all the stages of observation. Sequential application of pendimethalin (1000 g ha^{-1}, PE) + imazethapyr (100 g ha^{-1}, PoE) recorded the lowest density (15.56 m^{-2}) and dry weight (2.04 g m^{-2}) of *Cyperus* as compared to pendimethalin (1000 g ha^{-1}, PE) and imazethapyr (100 g ha^{-1}, PoE), respectively. Sequential application as well as alone application of pendimethalin and imazethapyr reduced the density and dry weight of *Cyperus rotundus* [29,30]. The low population and dry biomass of *Cyperus* in later stage was a result of drying during subsequent growing period of crop [31].

3.5 Impacts on *Echinochloa colona*

The lowest density (9.33 m^{-2}) and dry weight (0.86 g m^{-2}) of *Echinochloa* was recorded in dust mulching and were found to be lower than the paddy straw mulching and no-mulching (Figs. 3, 3a). Density and dry weight reflected the growth potential of the *Echinochloa* and its competitive ability with crop plants. Weedy check recorded the highest density and dry weight of *Echinochloa* while it was lowest under weed free (HW at 20 and 40 DAS). Pre-emergence

application of pendimethalin (1000 g ha^{-1}) followed by the post emergence application of imazethapyr (100 g ha^{-1}) recorded the lowest density (14.2 m^{-2}) and dry weight (1.36 g m^{-2}) of *Echinochloa* compared to alone application of pendimethalin (1000 g ha^{-1}, PE) and imazethapyr (100 g ha^{-1}, PoE). Sequential application of herbicide had an edge over the alone application of herbicides in reducing density and dry weight of *Echinochloa* [30,32].

3.6 Impacts on *Erogrostis pilosa*

All the mulch treatments of weed management proved superior to no-mulching in reducing density and dry weight of *Erogrostis* at all the stages of crop growth. Lowest density (10.4 m^{-2}) and dry weight (0.80 g m^{-2}) of *Erogrostis* was recorded under dust mulching followed by the density and dry weight with paddy straw mulching and no-mulching, respectively (Figs. 4, 4a). Increase in *Erogrostis* density and dry matter accumulation might be due to utilization of applied nutrients and available moisture in greater quantity by *Erogrostis*, resulting in more growth and dry matter accumulation. All herbicidal treatments reduced the density and dry weight of *Erogrostis* from beginning to the harvest of crop compared with weedy check. Sequential application of pendimethalin (1000 g ha^{-1}, PE) + imazethapyr (100 g ha^{-1}, PoE) proved most effective in arresting the population and dry matter accumulation of *Erogrostis* over pendimethalin (1000 g ha^{-1}, PE) and imazethapyr (100 g ha^{-1}, PoE), respectively. None of the treatments were comparable to weed free.

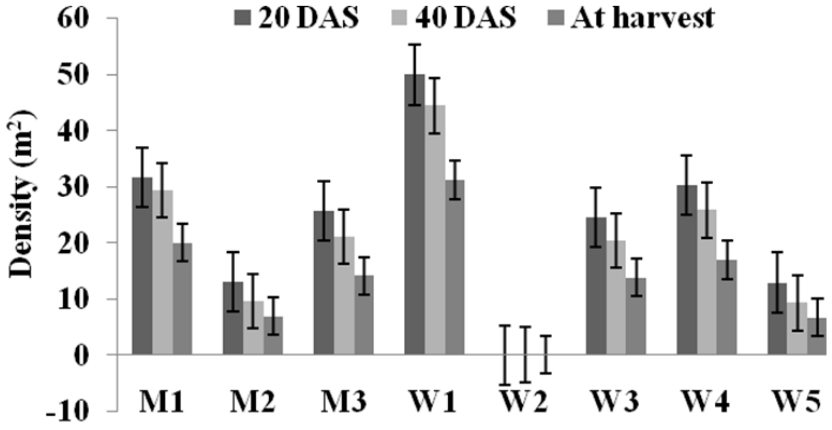

Fig. 1. Effect of mulching and weed management practices on density of *Cynodon dactylon*

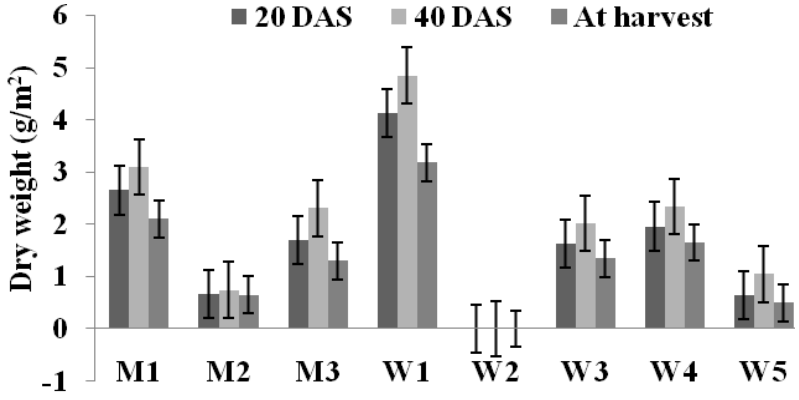

Fig. 1a. Effect of mulching and weed management practices on dry weight of *Cynodon dactylon*

Table 2. Biometrical observation on custard apple plantation

	Plant height (m)		Number of branches/plant		Canopy diameter (m)		Crown length (m)		Girth (m)	
	At the sowing time of greengram	At harvest of greengram	At the sowing time of greengram	At harvest of greengram	At the sowing time of greengram	At harvest of greengram	At the sowing time of greengram	At harvest of greengram	At the sowing time of greengram	At harvest of greengram
Mean	2.30	2.60	3.0	3.29	2.78	3.15	2.16	2.18	0.21	0.22
Range	1.2-2.80	1.4-2.95	2-4	2-6	1.5-2.9	1.8-3.45	1.05-2.7	1.15-2.75	0.15-0.24	0.16-0.24
SD	0.39	0.56	1.18	1.20	0.38	0.41	0.40	0.44	0.02	0.02

Table 3. Relative composition of weeds in weedy check at 40 DAS

Scientific name	Weeds (m^2)	Composition (%)
Echinochloa colona L.	47	25.8
Erogrostis pilosa L.	42	23.1
Cynodon dactylon L.	45	24.7
Cyperus rotundus L.	48	26.4
Total	182	100

Table 4. Effect of mulching and weed management practices on total weeds, crop yield and weed index

Treatment	Density (m^2)			Dry biomass (g/m^2)			Grain yield (kg/ha)	Straw yield (kg/ha)	Weed index (%)
	20 DAS	40 DAS	At harvest	20 DAS	40 DAS	At harvest			
Mulching									
M_1- No mulching	21.35(137.87)	20.50(129.87)	18.13(101.60)	6.70(10.86)	7.20(12.90)	6.39(9.90)	597	1597	21.15
M_2- Dust mulching	13.41(52.27)	11.28(37.33)	9.61(26.67)	4.28(2.76)	4.40(3.06)	4.30(2.81)	747	1797	1.44
M_3- Paddy straw mulching	19.00(109.87)	17.21(89.87)	14.99(67.47)	5.69(7.17)	6.17(8.74)	5.54(6.61)	712	1662	6.03
CD (P= 0.05)	0.94	1.06	0.48	0.28	0.30	0.20	12.92	13.02	
Weed management practices									
W_1- Weedy check	30.30(197.33)	28.75(181.78)	25.48(140.44)	10.73(15.03)	11.22(17.36)	10.18(13.21)	603	1603	20.42
W_2- Weed free (HW at 20 and 40 DAS)	2.83(0.00)	2.83(0.00)	2.83(0.00)	2.83(0.00)	2.83(0.00)	2.83(0.00)	758	1758	00
W_3- Pendimethalin (PE) 1000 g/ha	20.06(102.22)	18.04(83.56)	15.58(62.67)	5.78(6.72)	6.24(8.21)	5.74(6.59)	689	1689	8.99
W_4- Imazethapyr (PoE) 100 g/ha	22.26(124.89)	20.47(106.22)	17.70(79.56)	6.28(8.35)	6.70(9.77)	6.15(7.86)	651	1651	14.12
W_5- Pendimethalin (PE) 1000 g/ha + imazethapyr (PoE) 100 g/ha	16.99(75.56)	14.38(56.89)	12.45(43.56)	4.99(4.55)	5.44(5.82)	4.96(4.52)	726	1726	4.15
CD (P= 0.05)	0.88	1.13	1.19	0.27	0.31	0.21	8.34	8.65	

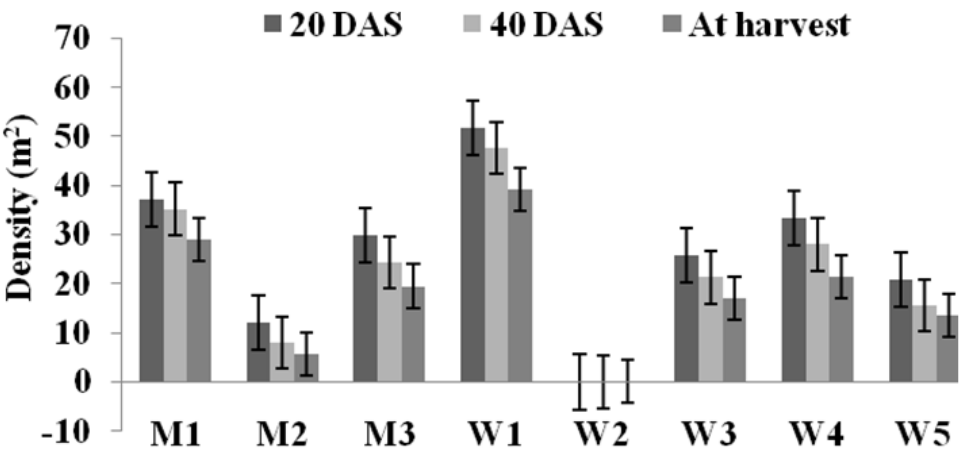

Fig. 2. Effect of mulching and weed management practices on density of *Cyperus rotundus*

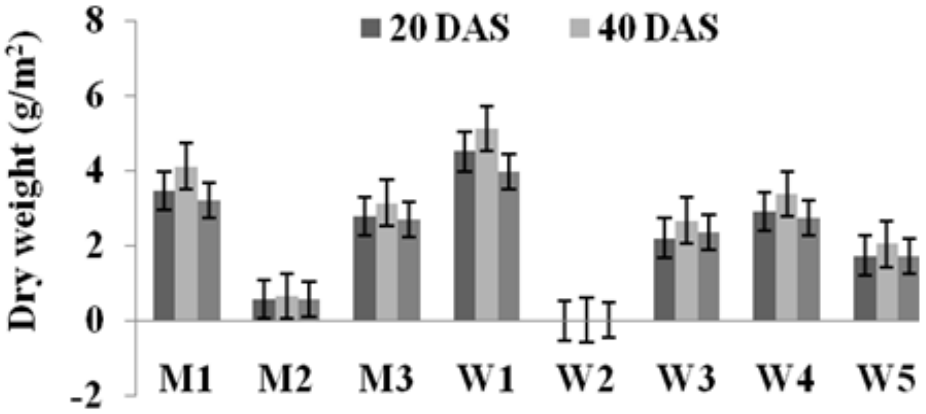

Fig. 2a. Effect of mulching and weed management practices on dry weight of *Cyperus rotundus*

3.7 Total Density and Dry Weight of Weed

Heavy infestation of weeds comprising of grass, sedge and broad-leaved weeds was observed under un-mulched (above Table 4). The lowest total density and dry weight of weed was recorded with dust mulching followed by paddy straw mulching. The decrease in density and dry weight of weed under dust mulching due to repeated soil manipulation that create unfavorable environment for weed seedling establishment [11-13]. Maximum total density and dry weight of weeds were observed under no-mulching, which facilitates favorable growing environment to weeds [8]. The treatment pre-emergence application of pendimethalin (1000 g ha^{-1}, PE) + imazethapyr (100 g ha^{-1}, PoE) recorded significantly least number of weed and weed dry matter than any other treatment except weed free check. This might be due to control of weeds during early growth stage by pre-emergence application of pendimethalin and post emergence application of imazethapyr at 20 DAS. The treatment combination of pre and post applied herbicide was able to control the further infestation of weeds in the crop. Further the crop covers the soil surface and smothers the growth of weeds results into least number of weeds at later stage of crop growth [32,33]. However, weed free (HW at 20 and 40 DAS) was found more effective than the herbicides, due to slow pace of growth of first flush of weeds, 20 days after sowing thereafter the emergence of new flushes of weeds could not attain full growth

under the shade of crop plants. These results are in close conformity with those of [20,34]. [16,17] reported the superiority of hand weeding over herbicidal treatments.

4. IMPACT ON WEED INDEX AND YIELD

Lowest weed index and significantly highest grain and straw were achieved under dust mulching followed by paddy straw mulching (above Table 4). Similar results also reported by [11,12]. Significantly the highest grain and straw yield and minimum weed index was recorded under the sequential application of pendimethalin (1000 g ha^{-1}, PE) + imazethapyr (100 g ha^{-1}, PoE) as compared to pendimethalin (1000 g ha^{-1}, PE) and imazethapyr (100 g ha^{-1}, PoE), respectively. These findings are also in line with [16,17,34].

The regression equation predicted linear increase in the grain and straw yield with a unit increase in the weed control efficiency. The evaluation of weed control efficiency of the different treatments and the regression of yield on it revealed that 1% increase in the weed control efficiency increased the grain yield by 1.873 kg ha^{-1} (Fig. 5) and in the straw yield by 2.085 kg ha^{-1} (Fig. 6). The increase in grain and straw yield by unit increase in the weed control efficiency also reported by [21].

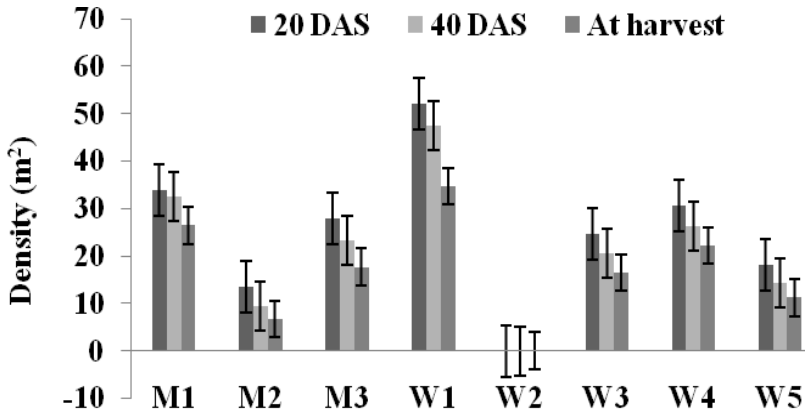

Fig. 3. Effect of mulching and weed management practices on density of *Echinochloa colona*

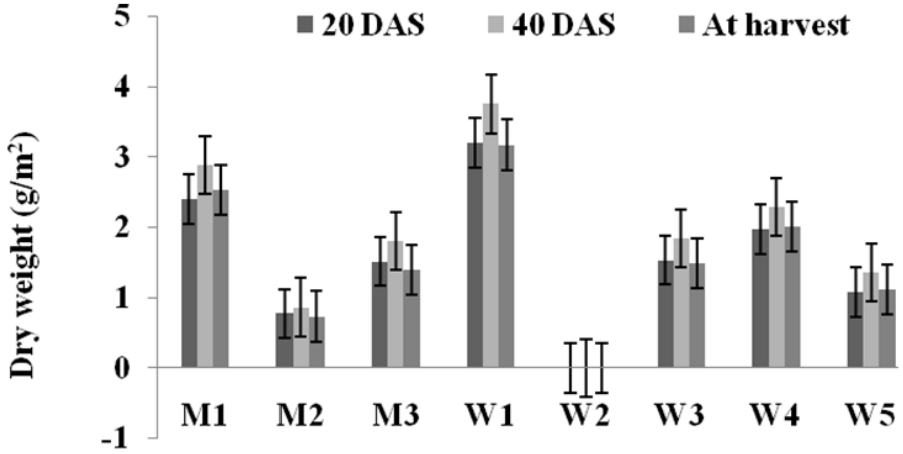

Fig. 3a. Effect of mulching and weed management practices on dry weight of *Echinochloa colona*

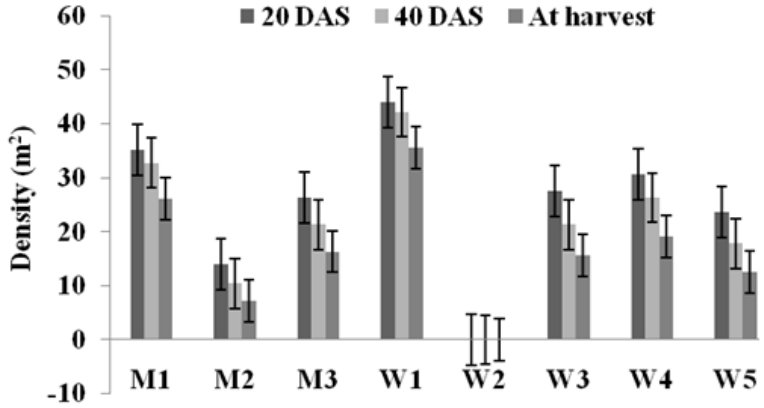

Fig. 4. Effect of mulching and weed management practices on density of *Erogrostis pilosa*

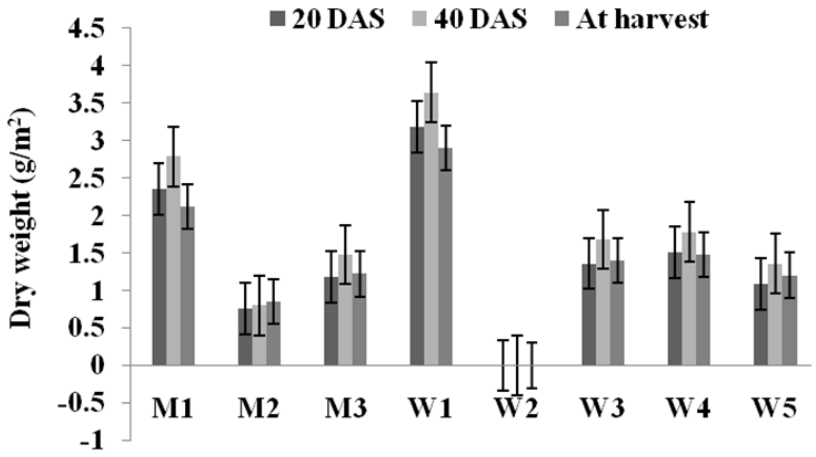

Fig. 4a. Effect of mulching and weed management practices on dry weight of *Erogrostis pilosa*

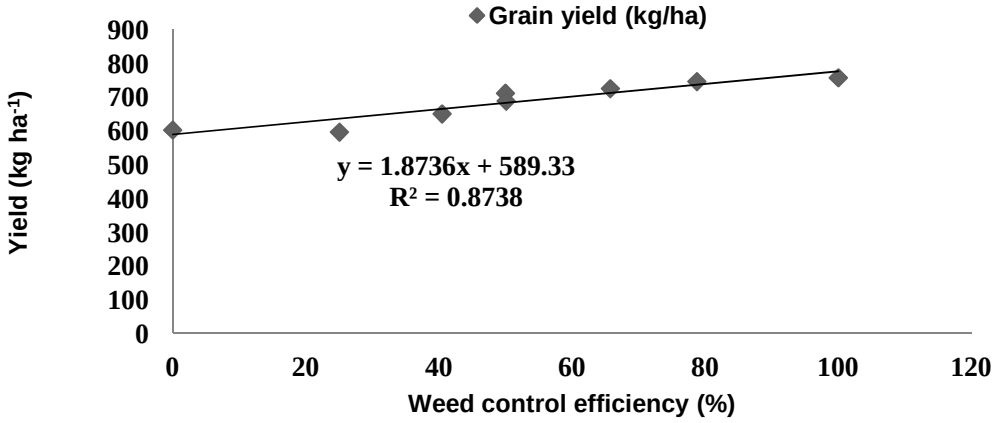

Fig. 5. Relationship between weed control efficiency and grain yield of greengram

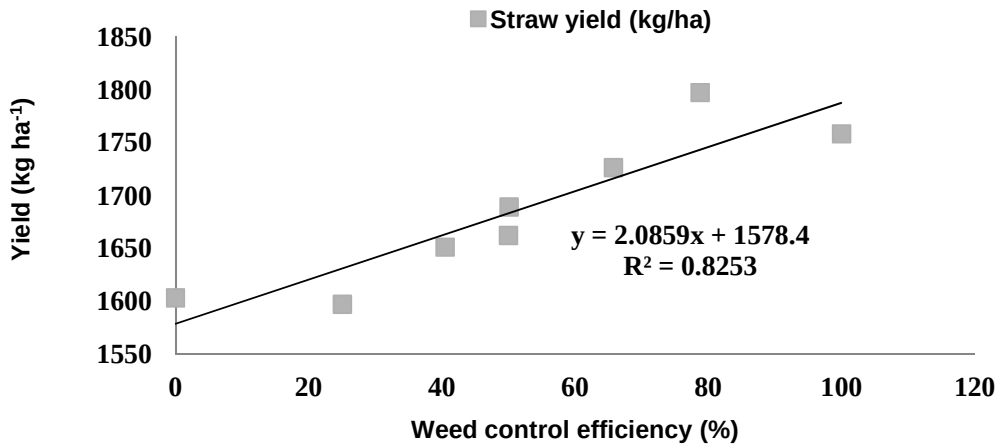

Fig. 6. Relationship between weed control efficiency and straw yield of greengram

5. CONCLUSION

Thus it is concluded that dust mulching and sequential application of pendimethalin (1000 g ha^{-1}, PE) + imazethapyr (100 g ha^{-1}, PoE) resulted significantly the highest grain and straw yield; and lowest weed index (1.44%), density and dry weight of *Cyperus rotundus*, *Echinochloa colona*, *Cynodon dactylon* and *Erogrostis pilosa*, as well as total density and dry weight of weeds over other weed management treatments.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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