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Evaluation of different types of mulching practices on weed management and productivity of winter maize in Chitwan, Nepal

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ABSTRACT

Sustainable agriculture requires the use of environmentally friendly management practices. Mulching is one of the most effective methods that can play a positive role in weed management, improving soil properties as well as increasing crop production. A field experiment was conducted at the research farm of National Maize Research Program (NMRP), Rampur, Chitwan, Nepal during winter season, 2016. The experiment was carried out in single factor randomized completely block design comprising of nine weed management methods with four replications. Data regarding the weed population, weed dry weight, yield attributes and yield were recorded during the study. Different weed management practices showed significant differences on weed dynamics and weed control efficiencies. Black polythene mulch and silver black mulch was found more effective to reduce total weed density and dry weight during whole crop season and remain comparable with other polythene mulch too. The effect of weed management practices observed on weed density and dry weight were reflected on grain yield. The highest grain yield was recorded in silver black plastic mulch (4537.50 kg ha^{-1}) followed by black plastic mulch (4068.20 kg ha^{-1}), clear plastic mulch (4065.22 kg ha^{-1}), green plastic mulch (3834.84 kg ha^{-1}) and weed free (3222.74 kg ha^{-1}) which were comparable to each other. At tasseling-silking stage among plastic mulch treatment, the higher moisture conservation observed on the black plastic mulch followed by clear plastic mulch, green plastic mulch and silver black plastic mulch. While comparing of plastic mulch with dead mulch, moisture on dead mulch remain higher than plastic mulch after 90 DAS. Thus, in humid subtropical region of western Chitwan, Rampur, the maize can be successfully cultivated by using different color of polythene mulch.

Introduction

Maize (*Zea mays* L.) is the second most important staple food commodity in the Nepalese agriculture and national economy. Maize is high yield potential crops and is considered as the

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nutritious food / feed as it contains about 72% starch, 10% protein, 4.8% oil, 9.5% fiber, 3% sugar and 1.7% ash (Chaudhary, 1983). It is grown in 891,583 hectares of land with total yield of 2,231,517 tons and average yield of 2.5 t ha^{-1} (MoAD, 2016). Its share on AGDP is 7.04% and on GDP share is 2.20% (MoF Economic survey, 2016). The importance of maize production in Nepal has increased sustainably in the past 30 years with nearly doubling maize area and production. Though, each year the country is importing maize worth of 4.5 billion rupees from India. Maize demand has been constantly growing by about 5% annually (Sapkota and Pokhrel, 2010). Nepalese population is increasing annually at rate of 1.28% for next ten years (CBS, 2014) and because of which, food grain demand will certainly increase in future. But, the production level of maize crop is minimal and many reasons are associated with it. Depletion of the organic matter content, disease, pests and weed infestation has been at the center of the problem in maize production.

Weed, a plant growing where it is not desirable, declines yield production and quality of crop plants and leads to higher cost in food production (Pandya et al. 2000). Apart from increasing the production cost, they also intensify the disease and insect pest problem by serving as alternative hosts. The critical period of weed control in maize is ranges from 1 to 8 weeks after the crop emergence (Ghosheh et al. 1996). The losses in yield vary from 28-100% depending upon intensity, nature, stages, and duration of weed infestation (Patel et al. 2006). Karki et al. (2010) recorded 48% reduction of grain yield in maize due to weed infestation in the hills of Nepal and yield loss depends upon types of weed flora and severity. Nature of weed problem in winter maize is quite different from that of the rainy season maize. In the rainy season emergence of maize and weed start simultaneously and first 20- 30 days are most critical to crop-weed competition. Contrarily in the winter maize, weed emerges most often after the first irrigation.

Thus, the need for increasing maize yield has called for better crop management practices including weed control strategies to enhance crop productivity. Since, there are various weed control methods, each being more suitable than others, for use in specific crop, specific time and location. Since, different weed control practices like cultural, physical, biological and chemical are used for weed control. Cultural methods are still useful tools but are laborious, time consuming and getting more expensive. Moreover, the labor problem is becoming acute day by day and will not be possible and economical to stick only to the traditional cultural weed control practices (Nadeem et al. 2010). Ahmad et al. (2004) reported that chemical weed control method is quick, more effective, time and labour saving method than others . In such situations use of herbicides becomes essential. Also, the continuous use of single herbicide is known to result in evolution of herbicide resistant in weed species and shift in weed flora (Thakur and Sharma, 1996). Physical method for example polythene mulch, biological mulch such as *Lantana camera* as a concept has also increased

dramatically in agriculture due to its' benefits on conserving soil moisture, moderating soil temperature, suppressing weeds, and improving crop performance (Momirovic, Oljaca, Dolijanovic & Postic, 2010). Viewing these facts, the present research was conducted to evaluate the alternative weed control methods with a view to identify the best for optimum maize production. Thus, the best approach of integrated weed management was formulated and executed to see the effect of herbicide, cowpea brown manuring effect, use of biological mulch such as *Lanatana camera* , plastic mulching effect along with the existing farmers practice of hand weeding in the major weed infested areas during winter season of 2016/17 in central terai of Nepal.

Materials and Methods

Field research was conducted in the research block of NMRP (National Maize Research Program) Rampur, Chitwan during the winter season from October 2016 to April 2017. The area is situated in Central terai of Nepal which lies at $27^0 37'$ North latitude and $84^0 25'$ East longitude with the elevation of 256 m above mean sea level. The soil of experimental plot was sandy loam in texture. Similarly, all other chemical properties from 0-15 cm depth of soil such as organic matter (3.23%), available potassium (207.15kg ha^{-1}) were found medium, total nitrogen (0.07%) was low while available phosphorus (229.30 kg ha^{-1}) was found high and soil pH was found slightly acidic (pH 5.58) . Similarly, from 15-30 cm depth of soil such as organic matter (3.16%), available potassium (178.42kg ha^{-1}) were found medium, total nitrogen (0.07%) was low while available phosphorus (122.36 kg ha^{-1}) was found high and soil pH was found slightly acidic (pH 5.59) based on soil rating chart given by (Khatri Chetri, 1991) and (Jaishy, 2000).

Experiment was carried out in Randomized Completely Block Design with four replication and nine treatments constituting 36 plots. The experiments consist following treatments weedy check, Weed free, Green Polythene Mulching, Clear Polythene Mulching, Cowpea co-culture, Black Polythene Mulching, Atrazine +one hand weeding @30 DAS, Silver black Polythene Mulching and Lantana camera Mulching.The field was ploughed 15 days prior to sowing using tractor. In Polythene mulch treatment plot plastic were laid down on field and hole was made. Seeds of Deuti maize variety were planted by jab planter in furrows at spacing of 25 cm opened 60 cm apart with the help of tractor drawn furrow opener on 5th October 2016. In case of control plot, weeds were allowed to grow along with the maize crop through out the crop cycle. In the weed free treatment, weeding was done manually to keep the plots free from weeds throughout the crop cycle. The crop was raised under irrigated condition as per the recommended package of practices.

Density and dry weight of weeds were recorded at 30, 60, 90 and at harvest. These data were subjected to square root transformation before analysis. Growth and yield characters were

recorded as per standard procedures and calculated using standard formulas. Weed control efficiencies were also calculated for each treatment. The analysis of variance of all parameters was determined using Gen STAT software program and the analyzed data were subjected to DMRT for the mean separation.

Results and discussion

Effect on weeds

Weed density

Average total weed density of experiment declined from 15.86 weeds per square meter at 30 DAS to 11.05 weeds per square meter at 90 DAS and again it was increased at harvest (17.98 m^{-2}). Declining trend was observed as the result of various weed management treatment. Total weed density at all dates of observations was significantly influenced by weed management practices. At 30 DAS, all weed management practices significantly reduced the weed density compared to weedy check. Total weed density recorded in weedy check were significantly higher (740.42 weeds per square meter) than that of all treatments. Whereas, lowest recorded in black plastic mulch treated plot and which was statistically similar with silver black polythene mulch.

At 60 DAS, the highest weed density recorded in weedy check (403.00 weeds m^{-2}) in comparison to all treatments but was statistically similar with *Lantana camera* mulch (315.67 weeds m^{-2}) and cowpea co-culture (296.67 weeds m^{-2}). The lowest weed density was recorded in black polythene mulch (39.17 weeds m^{-2}) which was statistically similar with silver black mulch and atrazine +one hand weeding (104.17 weeds m^{-2}).

At 90 DAS, all weed management practices significantly reduced the weed density as compared to weedy check. Total weed density recorded in weedy check were significantly higher (322.92 weeds m^{-2}) than that of all treatments. Whereas, the lowest recorded in silver black plastic mulch (42.2 weeds m^{-2}) which was statistically similar with black plastic mulch (46.67 weeds m^{-2}), green polythene mulch (60 weeds m^{-2}) which were superior for weed management than atrazine+ one hand weeding (98.33 weeds m^{-2}), clear polythene mulch (130.83 weeds m^{-2}),Lantana camera mulch (185.42 weeds m^{-2}), cowpea co-culture (247.04 weeds m^{-2}) and weedy check(322.91 weeds m^{-2}) .

Similarly, at harvest, the highest weed density recorded in weedy check (543.25 m^{-2}) than that of all treatments and it was statistically similar with all other treatments except black plastic mulch (121.67 weeds m^{-2}) and silver black mulch (166.67 weeds m^{-2}). Finding was supported by (Bond and Grundy, 2001) who reported the role of different color of polythene mulch have effect of regulating the environment, suppressing weeds. Similarly (Abdullahi et al., 2016) found maximum

reduction in density of the weeds at maturity in Paddy straw mulch and black polythene mulch treatments (61.0 weeds m^{-2}).

Table 1. Total weed density (numbers of weeds per square meter) as influenced by weed management practices in winter maize at different date of observation.

Treatments	Total weed density (numbers of weeds per square meter)			
	30 DAS	60 DAS	90 DAS	At harvest
Weedy check	27.17^{a} (740.42)	20.03^{a} (403.00)	17.54^{a} (322.92)	23.16^{a} (543.25)
Green polythene	14.35^{c} (205.83)	12.37^{bcd} (156.25)	7.66^{ef} (60.00)	17.31^{ab} (312.50)
Clear polythene	14.10^{c} (212.92)	13.75^{bc} (198.75)	11.21^{cd} (130.83)	21.12^{a} (450.00)
Cowpea co-culure	23.35^{ab} (546.2)	17.18^{ab} (296.67)	15.54^{ab} (247.09)	23.09^{a} (539.75)
Black polythene	5.16^{d} (27.50)	6.27^{e} (39.17)	6.51^{f} (46.67)	10.71^{c} (121.67)
Atrazine+ one hand weeding	20.48^{b} (429.17)	9.30^{cde} (104.17)	9.90^{de} (98.33)	17.86^{ab} (345.00)
Silverblack mulch	5.98^{d} (36.67)	7.69^{de} (83.75)	6.47^{f} (42.92)	12.38^{bc} (166.67)
Lanatana camera mulch	16.29^{c} (284.58)	17.59^{ab} (315.67)	13.56^{bc} (185.42)	18.20^{ab} (340.83)
SEm (±)	1.42	1.68	1.02	1.85
LSD (=0.05)	4.17	4.95	3.01	5.43
CV, %	17.90	25.80	18.50	20.50
Grand mean	15.86	13.02	11.05	17.98

Note: Atrazine 0.75 kg a.i. ha^{-1}; Data subjected to square-root ($\sqrt{X+0.5}$) transformation, and figures in the parenthesis are original values. Mean separated by DMRT and columns represented with same letter(s) are non-significant at 5% level of significance.

Total weed dry weight

Average total weed dry weight of experiment decreased from 7.99 g m^{-2} to 7.80 g m^{-2} at 60 DAS and again increased from 60 DAS (7.80 g m^{-2}) to 12.93 g m^{-2} at harvest. All weed management practices significantly reduced the weed dry weight compared to weedy check. At all date of observation weedy check recorded the highest weed dry weight. Here, black plastic mulch recorded lower weed density at all date of observation as compared to other treatments (Table 2).

At 30 DAS, all weed management practices significantly reduced the weed dry weight compared to weedy check. Total weed dry weight recorded in weedy check were significantly higher (162.44 g m^{-2}) than that of all treatments. Whereas, the lowest recorded in black plastic mulch treated plot (8.05 g m^{-2}) and which was statistically similar with silver black plastic mulch (16.27 g m^{-2}). Similarly, at 60 DAS, the highest weed dry weight recorded in weedy check (168.71 g m^{-2}) in comparison to all treatments. The lowest weed dry weight was recorded in black polythene mulch (10.53 g m^{-2}) which was statistically similar with Silver black plastic mulch (33.25 g m^{-2}).

At 90 DAS, the highest weed dry weight was recorded in weedy check (177.67 g m^{-2}) which was statistically similar with cowpea co-culture (159.81 g m^{-2}) and *Lantana camera* as mulch (129.58 g m^{-2}). Whereas, the lowest recorded in black plastic mulch (18.89 g m^{-2}) which was statistically similar with silver black plastic mulch (25.23 g m^{-2}), atrazine + one hand weeding(29.12 g m^{-2}), green polythene mulch (36.63 g m^{-2}).Similarly, at harvest, the highest weed dry weight was recorded in weedy check (279.00 g m^{-2}) than that of all. The lowest weed density was recorded in black polythene mulch (82.00 g m^{-2}). (Rajablariani et al. 2012) concluded that black plastic mulch reduced weed dry weights by 94.7% in sweet corn.

Table 2. Total weed dry weight as influenced by weed management practices in winter maize at different date of observation.

Treatments	Total weed dry weight (g m^{-2})			
	30DAS	60DAS	90DAS	At harvest
Weedy check	12.63^{a} (162.44)	12.91^{a} (168.71)	13.25^{a} (177.67)	16.64^{a} (279.00)
Green polythene	6.44^{cd} (41.61)	6.32^{de} (41.00)	5.91^{bc} (36.63)	12.54^{abc} (161.25)
Clear polythene	7.90^{c} (67.51)	8.40^{bcd} (71.76)	7.71^{b} (69.26)	15.66^{a} (248.13)
Cowpea co-culture	11.95^{ab} (146.95)	9.21^{bc} (86.03)	12.52^{a} (159.81)	13.93^{ab} (193.92)
Black polythene	2.90^{e} (8.05)	3.29^{f} (10.53)	4.11^{c} (18.89)	8.49^{c} (82.00)
Atrazine +one hand weeding	8.88^{c} (84.66)	7.03^{cde} (58.95)	5.34^{bc} (29.12)	12.50^{abc} (159.25)
Silver black mulch	4.05^{de} (16.27)	4.98^{ef} (33.25)	4.91^{bc} (25.23)	9.41^{bc} (97.46)
Lantana camera mulch	9.21^{bc} (88.33)	10.26^{b} (106.44)	11.28^{a} (129.58)	14.31^{a} (222.25)
SEm (±)	0.97	0.82	1.04	1.44
LSD (=0.05)	2.86	2.41	3.04	4.23
CV, %	24.30	21.00	25.50	22.20
Grand mean	7.99	7.80	8.13	12.93

Note: Atrazine 0.75 kg a.i ha^{-1}. Data subjected to square-root ($\sqrt{X+0.5}$) transformation, and figures in the parenthesis are original values. Mean separated by DMRT and columns represented with same letter (s) are non-significant at 5% level of significance, ns, non-significant.

Weed control efficiency

Weed control efficiency at all dates of observations found significantly influenced by different weed management practices. However, remarkably higher grand mean values of WCE were recorded at 30 DAS (7.90%).Further, different weed management practices significantly improved the WCE over the control plot. The values of weed control efficiency recorded in black plastic mulch (96.21, 90.10, 85.62, and 74.30%) were significantly higher as compared to cowpea co-culture at 30

DAS, cowpea co-culture and Lantana camera mulch at 60 DAS and 90 DAS and clear polyether mulch and cowpea co-culture at harvest. Expect these treatments; black polythene mulch was comparable with other treatments.

Table 3. Weed control efficiency as influenced by weed management practices in winter maize at different date of observation.

Treatment	Weed control efficiency			
	30 DAS	60 DAS	90 DAS	At harvest
Green polythene	8.50^{ab} (71.79)	7.72^{a} (60.03)	8.81^{a} (77.52)	6.15^{ab}(41.45)
Clear polythene	8.48^{ab} (71.85)	6.73^{ab} (47.25)	7.67^{a} (58.48)	3.48^{bc} (15.44)
Cowpea co-culture	4.49^{c} (24.48)	4.52^{bc} (24.43)	3.98^{b} (18.78)	1.00^{c} (0.62)
Black polythene	9.83^{a} (96.21)	9.52^{a} (90.10)	9.27^{a} (85.62)	8.58^{a} (74.30)
Atrazine+ one hand weeding	6.39^{bc} (42.25)	8.39^{a} (72.67)	8.04^{a} (64.66)	6.02^{ab} (38.65)
Silverblack mulch	9.78^{a} (95.12)	8.55^{a} (76.86)	9.21^{a} (84.46)	8.18^{a} (67.95)
Lantana camera mulch	7.84^{ab} (62.21)	2.94^{c} (17.34)	5.15^{b} (32.51)	5.61^{ab}(35.30)
SEm (±)	0.676	0.915	0.651	0.945
LSD (=0.05)	2.007	2.720	1.933	2.806
CV, %	17.1	26.5	17.5	33.9
Grand mean	7.90	6.91	7.45	5.57

Note: Atrazine 0.75 kg a.i ha^{-1}. Data subjected to square-root ($\sqrt{X+0.5}$) transformation, and figures in the parenthesis are original values. Mean separated by DMRT and columns represented with same letter (s) are non-significant at 5% level of significance, ns, non-significant.

Weed Control Index (WCI)

Weed Index (WI) is a derived parameter from the crop yields obtained across the treatments of weed control researches (Gill and Vijayakumar, 1969). It is a measure of crop yield loss accrued across treatments in comparison to a weed free plot or in certain cases the minimum weed infested plots like two or three hand weeding (if as good as weed free check) adopted in an experiment. It is the ultimate parameter towards appraisal of the superiority or inferiority of several treatments and is worked out in almost all weed control researches.

With respect to weed management methods, higher weed control index (WCI) was observed in black plastic mulch at all days after sowing. Weed control index at 30, 60, 90 and at harvest were 94.79, 93.28, 89.78, 67.94% under black polythene mulch. The lowest weed control index was recorded on cowpea co-culture at 30 and 90 DAS, *Lantana camera* as mulch at 60 DAS, and clear polythene at harvest.

Table 4. Weed control index as influenced by weed management practices in winter maize at different date of observation.

Treatment	Weed control index			
	30 DAS	60 DAS	90 DAS	At harvest
Green polythene	8.50^{abc} (72.21)	8.46^{ab} (72.41)	8.96^{a} (79.92)	6.49^{ab} (42.55)
Clear polythene	7.38^{abc} (57.16)	7.42^{b} (55.52)	7.46^{a} (57.96)	2.99^{b} (11.14)
Cowpea co-culture	2.86^{d} (11.02)	7.07^{bc} (49.51)	2.47^{c} (9.92)	5.28^{ab} (28.43)
Black polythene	9.76^{a} (94.79)	9.68^{a} (93.28)	9.49^{a}(89.78)	8.15^{a} (67.94)
Atrazine+ one hand weeding	6.82^{bc} (48.05)	8.13^{ab} (67.04)	9.12^{a} (82.76)	5.95^{ab} (40.06)
Silver black mulch	9.47^{ab} (89.25)	9.06^{a} (82.57)	9.10^{a} (82.93)	8.17^{a} (67.05)
Lantana camera mulch	5.92^{c} (39.0)	5.67^{c} (34.64)	5.30^{b} (27.96)	3.45^{b} (21.80)
SEm (±)	0.85	0.50	0.66	1.11
LSD (=0.05)	2.51	1.49	1.97	3.30
CV, %	23.30	12.70	17.90	38.40
Grand mean	7.24	7.93	7.41	5.78

Note: Atrazine 0.75 kg a.i ha^{-1}. Data subjected to square-root ($\sqrt{X+0.5}$) transformation, and figures in the parenthesis are original values. Mean separated by DMRT and columns represented with same letter (s) are non-significant at 5% level of significance, ns, non-significant.

Effect on crop

Grain yield and yield attributes

Average number of plants population was 52986.11 per hectare ranged from 60416.67 to 38541.67 per hectare. Number of plant population was significantly influenced by weed management method. Comparatively higher was recorded under black plastic mulch as compared to other weed management method. Black polythene mulch treated plots resulted in highest number of plants (60416.67 ha^{-1}) which was higher than silver black mulch, clear, green, *Lantana camera* mulch, weed free and also comparable among them. Lowest number of plants was obtained in cowpea co-culture plot (38541.67 ha^{-1}).

Average number of ears harvested was 43187.66 per hectare ranged from 24183.42 to 56458.33 per hectare. Number of ear harvested was significantly influenced by weed management method. Comparatively higher was recorded under clear plastic mulch as compared to other weed management method. Clear polythene mulch treated plots resulted in highest number of ear (56458.33 ha^{-1}) which was significantly higher than weed free, weedy check, black polythene mulch, atrazine with one hand weeding and *Lantana camera* mulch and statistically at par with green polythene mulch (51750 ha^{-1}) treatment and Silver Plastic mulch treatment. Summers and

Stapleton (2002) also recorded highest total number of ear harvested per ha recorded in clear plastic mulch plot. Black polythene mulch and weedy free resulted the similar number of ears per ha. Lowest number was obtained in weedy check plot (24183.42 ha^{-1}) which was statistically at par with Cowpea intercropping with maize.

The average number of kernels per cob was 234.05 and it ranged from 84.63 to 299.76 depending upon the treatments. With respect to weed management methods significantly higher number of grains per cob was recorded in silver mulch plastic (299.76) followed by clear polythene mulch (285.36), green polythene mulch (272.83), black polythene mulch (269.47) followed by *Lantana camera* as mulch (262.82), weed free (237.19) and atrazine in combination with one hand weeding (234.64). This was also reflected on grain yield. All mulch treatment along with atrazine in combination with one hand weeding treatment remains significantly higher than cowpea intercropping with maize and weed check. Finally, weedy check (8.63) recorded significantly lower number of kernels per ear in comparison to all other weeding treatments.

The value of thousand kernels weights ranged from 22.57 to 309.62 g depending upon the treatments and its average value was 288.9 g. There observed significantly lower thousand kernels weight was recorded in weedy check (229.57 g) as compared to all other weed management treatments. Moreover, the higher thousand grain weight obtained in the green polythene mulch (309.62 g) and statistically similar with other treatments except weedy check. Finally, weedy check (229.57g) recorded significantly lower number of thousand kernels weight in comparison to all other weeding treatments. The average bareness percentage was 6.75 and not affected significantly by weed managements. However, it was slightly higher in weedy check plot and lower in black polythene mulching. Mean sterility percentage was found 19.05% ranging from 15.11% to 25.5% (Table 5). Sterility percentage was significantly influenced by different weed management practices. Least sterility percentage was recorded in black polythene mulch treated plot (15.11 %) and followed by clear polythene mulch (15.44%) followed by Green polythene mulch (16.69%), silver black mulch (18.6%) and weed free(18.61%).Weedy check (25.5%) had high influence on sterility percentage. The grain yield of maize variety 'Deuti' was influenced significantly by weed management methods. There obtained significantly lower grain yield was achieved in weedy check (718.18 kg ha^{-1}) in comparison to all other weeding treatments. On the other hand, the grain yield obtained in silver black plastic mulch condition (4537.5 kg ha^{-1}) was found highest. However there obtained remarkably higher grain yield in black polythene mulch (4068.2 kg ha^{-1}) which was at par with clear polythene mulch (4065.22 kg ha^{-1}), green polythene mulch (3834.84 kg ha^{-1}), weed free (3222.74 kg ha^{-1}), and even yield under silver black plastic mulch. Higher in mulched treatments might be due to its effect on soil temperature, soil moisture and weed suppression. Finding was

supported by (Rajablariani & Sheykhmohamady, 2015) who reported that highest fresh kernel yield in white on black mulched treatment followed by clear, blue and black polythene mulched treatment. (Gul et al., 2011) also reported the highest grain yield was recorded in hand weeding which remain at par with black plastic mulch. The yield obtained under the weedy check and cowpea co-culture was statistically similar. All polythene mulch was as superior as the weed free and atrazine + one hand weeding at 30 DAS in terms of grain yield.

Table 5. Yield and Yield attributes as influenced by weed management practices in winter maize.

Treatment	No. of plants per ha	No. of ear harvested per ha	No. of kernels per ear	1000 kernels weight (g)	Bareness (%)	Sterility (%)	Grain yield (kg ha^{-1})
Weedy check	50625.00^{bc}	24183.42^{e}	84.63^{c}	229.57^{b}	3.95 (19.37)	25.5^{a}	718.18^{e}
Weedy free	53333.33^{abc}	47500.0^{bc}	237.19^{a}	291.87^{a}	2.57(6.58)	18.61^{bcd}	3222.74^{abc}
Green polythene	54166.67^{abc}	51750^{ab}	272.83^{a}	309.62^{a}	1.86(3.03)	16.69^{cd}	3834.84^{abc}
Clear Polythene	57708.33^{ab}	56458.33^{a}	285.36^{a}	293.74^{a}	1.64(2.53)	15.44^{d}	4065.22^{ab}
Cowpea co-culture	38541.67^{d}	27569.44^{e}	159.78^{b}	269.1^{a}	3.10(10.88)	21.19^{b}	1073.05^{de}
Black polythene	60416.67^{a}	49958.33^{b}	269.47^{a}	304.43^{a}	1.59(2.38)	15.11^{d}	4068.20^{ab}
Atrazine + one hand weeding	50000.00^{c}	37436.11^{d}	234.64^{a}	300.93^{a}	2.86(7.86)	20.66^{b}	2356.13^{cd}
Silver black mulch	58125.00^{a}	50625.00^{ab}	299.76^{a}	304.81^{a}	1.99(3.54)	18.6^{bcd}	4537.50^{a}
Lantana camera mulch	53958.33^{abc}	43208.33^{cd}	262.82^{a}	296.35^{a}	2.25(4.63)	19.62^{bc}	2705.16^{bc}
SEm (±)	2196.4	2042.80	21.69	12.35	0.51	1.195	495.30
LSD (=0.05)	6410.8	5962.40	63.31	36.04	Ns	3.487	1445.60
CV, %	8.3	9.50	18.50	8.50	42.4	12.5	33.50
Grand mean	52986.11	43187.66	234.05	288.94	6.75	19.05	2953.00

Note: Atrazine 0.75 kg a.i ha^{-1}. Data subjected to square-root ($\sqrt{X+0.5}$) transformation, and figures in the parenthesis are original values. Mean separated by DMRT and columns represented with same letter (s) are non-significant at 5% level of significance, ns, non-significant.

Conclusion

Total dry weight and density of weed was found lower in black polythene mulch and silver black polythene mulch during whole growing season as compared to weed free and atrazine +one hand weeding at 30 DAS, but remain statistically at par with other polythene mulch. Similarly, grain yield was found to be higher in silver black polythene mulch plot which remain higher than weed free and atrazine + one hand weeding, but remain statistically at par with other polythene mulches. Hence, winter maize can be successfully grown by using different color polythene mulch.

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Conflict of interest

Authors declare no conflict of interest.

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