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Influence of paddy straw and polythene sheet mulching on weed flora and their index in wheat (*Triticum aestivum* L.)

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Abstract
An experiment consisted treatments of paddy straw mulching @ 6t ha^{-1} at 8-10 DAS, black polythene sheet mulching at 8-10 DAS, two hand weeding (20 and 40 DAS) and unweeded control was carried out in randomized block design with 3 replications at Crop Research Farm, Nawabganj, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (Uttar Pradesh) in wheat cv. K1006 during Rabi 2019-20. A wide spectrum of weed flora comprising *Phalaris minor, Cynodon dectylon, Avena fatua* of grassy weeds, *Chenopodium album, Convolvulus arvensis, Anagallis arvensis, Melilotus indica, Coronopus didymus, Rumex dentatus, Fumaria parviflora, Cyperus rotundus* and *Vicia hirsuta* of broad leaf weed and *Cyperus rotundus* of sedges were observed. Polythene sheet mulching was invariably found more effective to reduce the weed density in comparison to paddy straw mulching and hand weeding. However, paddy straw mulching was also appeared superior to hand weeding. The minimum weed index (3.4%) was recorded under hand weeding followed by polythene sheet mulching (6.72%) and paddy straw mulching (11.79%). The unweeded control recorded (43.09%) weed index. Polythene sheet mulching and /or paddy straw mulching could therefore be exploited to reduce the weed infestation significantly and sustain the productivity and green economy in wheat cultivation.

Keywords: Wheat, paddy straw, polythene sheet, mulching, weed infestation

Introduction
Wheat (*Triticum aestivum* L.), being an important prehistoric crop, is backbone of our national food security system. It is grown in a wide range of agro-climatic conditions and therefore faces multiple biotic and abiotic stresses. The presence of weeds in a crop may have adverse effects on production in several ways. Weeds compete with crops for light, moisture, nutrients and space, in addition to harvesting costs, reducing product quality and increasing the risk of fire. In order to increase wheat yields, it is essential to manage weeds effectively in its cultivation. Weeds may cause the yield loss of wheat from7 to 50% (Chhokar *et al*., 2012) [4], 15 to 50% (Jat *et al*., 2003) [10] and 18 to 73% (Pandey and Verma, 2004) [12] based on the kind of weed flora and their intensity. The prominent weeds found in wheat crop are *Phalaris minor, Avena ludoviciana, Chenopodium album, Medicago denticulate, Melilotus alba, Melilotus indica, Fumeria parviflora, Vicia hirsuta, Vicia sativa, Coronopus didymus* and *Rumex acetosella*, etc. The several options like manual weeding and herbicide application are available for the efficient management of weeds applied pre sowing and successive crop growth stages. Manual weeding is common practice for wheat, but it is very expensive and the availability of labour for this operation is problematic, particularly during peak periods. The continuous and indiscriminate use of herbicides, on the other hand, can cause numerous problems such as weed resistance, crop and soil residues, pollution risks, and health risks to non-target organisms (Singh *et al*., 2012) [15]. Wheat is cultivated after the harvest of rice. In addition to increasing productivity of rice, the heavy amount of rice straw is disposed by farmers through its burning in the field only. It is important to mention that open burning is widely practiced worldwide, but its intensity varies. Burning rice crop residues causes air pollution by emitting trace gases that form a dark cloud,

which is detrimental to human health: heating land and killed soil microorganisms, harming its productivity and the environment. In order to cope up the burning rice residue problem, crop residue can be utilized by using different methods, among them, it is very easy to use it as mulch in succeeding crops. Organic mulch also provides organic matter and mineral nutrients, stimulates soil micro-flora, increases the biological activity of soil and participates in the nutrient cycle (Fang *et al*., 2011) [5]. Plastic mulching materials are now being extensively used for conservation of soil moisture, soil temperature moderation, suppression of weeds and increased soil productivity and better crop production. (Peng *et al*., 1999; Tindall *et al*., 1999; Murugan and Gopinath, 2001) [13, 16, 11]. However, film mulching shortened the crop phenology by 4-9% due to the higher soil temperature compared with non-mulching (He *et al*., 2011) [9]. The black film mulch system leads to greater crop growth and higher economic benefits than the transparent film mulch system. Further, Zhao *et al*. (2019) [17] showed that straw mulching resulted in similar grain yield that were comparable with plastic mulching. Besides, straw acts as a potential source of slow releasing nitrogen, the straw mulching 0-200 cm soil profile contained more nitrate -N than the corresponding plastic mulching soil profiles. Therefore, the present investigation was taken up to study the comparative efficacy of paddy straw and polythene sheet mulching in context to hand weeding being commonly practiced leading to sustain the wheat production.

Materials and Methods

The present investigation was carried out at Crop Research Farm, Nawabganj, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (Uttar Pradesh) in wheat cv. K1006 during Rabi 2019-20. The experimental site is situated between latitude range of 25.26° to 28.58° North and at longitude of 79.31° to 80.34° East with a height about 125.9 meter above the mean sea level. The annual rainfall was about 800 mm extending normally from July to mid-October with a few showers in winter season. The experimental field was characterized by having organic carbon 0.49, available nitrogen (175 kg/ha), available potassium (19.30 kg/ha), available phosphorus (145 kg/ha), sandy loam in nature and alkaline in reaction (pH 7.8). The experimental crop was sown using 100 kg seed per hectare with a row to row spacing of 23 cm apart. Prior to sowing the required quantity of wheat seed was treated with Bavistin @ 2.5 gram per kg of seed for healthy growth and development of the crop. The paddy straw @ 6 t ha^{-1} and black polythene sheet were spread-out between the rows of wheat after 8 to 10 days of sowing. Two hand weeding at 20 and 40 days after sowing were practiced in order to remove the weeds as per treatment. Fertilizers @ 150 kg N ha^{-1}, 60 kg P_2O_5 ha^{-1} and 40 kg ha^{-1} K_2O were applied. The sources of fertilizers were Urea, Di-Ammonium Phosphate and Muriate of Potash. Half dose of nitrogen fertilizer and full doses of phosphorus and potassium were placed below the seed prior to sowing. Rest 50% nitrogenous fertilizer was broadcasted in two equal splits at tillering stage and pre-heading stage of the crop. Four irrigations were supplemented in crop at 23, 45, 68, 83 days after sowing of wheat. Weed population was recorded at 30, 60, 90 days after sowing and at harvest. For recording the weed population, an area of 0.5 m × 0.5 m (0.25 m^2) was marked at three spots in each treatment and observations were made from the same marked area and average was worked out and expressed in weed number per m2 area. The crop was harvested manually. First of all, plot borders were harvested from all the sides of the plot separately and then net plots were harvested. The harvested materials from each plot were tied, labelled and threshed with the help of thresher. After threshing and winnowing, the grain produced was weighted with physical balance in kg $plot^{-1}$ and finally converted in to q ha^{-1}.

Weed index was computed by using the following formula:

$$\text{Weed Index (WI)} = \frac{X - Y}{Y} \times 100$$

Where

X – Yield from weed free plot Y- Yield from treated plot

The final data were transformed using the formula $\sqrt{(X + 0.5)}$ for statistical analysis according to Fisher (1937) [6].

Results and Discussion

Divergent weed flora like *Phalaris minor*, *Cynodon dectylon*, *Avena fatua of grassy weeds*, *Chenopodium album*, *Convolvulus arvensis*, *Anagallis arvensis*, *Melilotus indica*, *Coronopus didymus*, *Rumex dentatus*, *Fumaria parviflora*, *Cyperus rotundus*, and *Vicia hirsuta* of broad leaf weed and *Cyperus rotundus* of sedges were recorded (Table 1). Similar weed flora of wheat crop under normal as well as late sown condition have also been reported by Bharat *et al*. (2012) [1], Bhullar *et al*. (2012) [2], Chaudhari *et al*. (2017) [3] and Singh *et al*. (2023) [14].

Table 1: Weed flora in unweeded plot of experiment in wheat cv. K1006

Grasses			
Common name	**Weed species**	**Family**	**Habitat**
Canary grass	*Phalaris minor*	Poaceae	Annual
Bermuda grass	*Cynodon dactylon*	Poaceae	Perennial
Wild oat	*Avena fatua*	Poaceae	Annual
Broad leaf weeds			
Lambs quarter	*Chenopodium album* L.	Chaenopodiacee	Annual
Blue pimpernal	*Anagallis arvensis* L.	Primulaceae	Annual
Swine Wartcress	*Coronopus didymus*	Brassicaceae	Perennial
Field binder	*Convonvulus arvensis* L.	Convonvulaceae	Perennial
Sweet clover	*Melilotus indica*	Leguminaceae	Annual
Common vetch	*Vicia hirsuta*	Leguminaceae	Annual
Dock	*Rumex dentatus*	Polygonaceae	Perennial
Fumitory	*Fumaria parviflora*	Papaveraceae	Annual
Sedges			
Nut Sedge	*Cyperus rotundus*	Cyperaceae	Perennial

Weed density measures the number of the species in a unit area. Weed density varied species wise as well as crop growth stages. The status of weed density is in a critical stage of infestation need quick action to tackle the problem sustainably. Timely control of the weed by adopting appropriate methods especially with an integrated weed management approach is essential. The weed density was increased with increasing the crop stages even at maturity in un-weeded control mainly due to the rejuvenation of weeds after having been interacted with rains even at later stages also. All the treatments were found to be significantly effective in reducing the weed density in comparison to un-weeded control. The polythene sheet mulching reduced the weed density more actively followed by paddy straw treatment. It reflects that germination of weed seeds as well as growth of germinated seed were depressed by the action of both mulches. Similar results have also been reported by Murugan and Gopinath (2001) [11], Zhao *et al*. (2019) [17] and He *et al*. (2011) [9]. Weed index is defined as the per cent reduction in the seed yield under a particular treatment due to the presence of weeds in comparison to the seed yield obtained in weed free plot as suggested by Gill and Kumar (1969) [8]. The maximum weed index (43%) was observed under un-weeded control. The minimum weed index (3.49%) was noticed by hand weeding done at 20 and 40 DAS followed by polythene sheet mulching

(6.72%) and paddy straw mulching (11.79%). It advocates that weed infestation led to the heavy losses in grain yield in wheat. Further, comparatively less reduction in grain yield might be due to lessor crop weed competition in these treatments as compared to un-weeded control resulted higher yield and vice-versa and thus reduced the weed index. Similarly, there are the reports that weed infestation may cause the yield loss of wheat from 7 to 50% (Chhokar *et al*., 2012) [4], 15 to 50% (Jat *et al*., 2003) [10] and 18 to 73% (Pandey and Verma, 2004) [12] based on the kind of weed flora and their intensity. It is also visualized that polythene sheet mulching was found comparatively superior than the paddy straw mulching on over all weed infestation which might be due the rejuvenation of the most of weeds owing to the rain falls occurred at later stages of crop.

Table 2: Effects of paddy straw and polythene sheet mulching on various weed density (m^{-2}) in wheat cv. K 1006

Treatment	Crop stage (DAS)			
	30	60	90	At harvest
Phalaris minor				
Paddy straw (6 t ha^{-1}) at 8-10 DAS	1.00 (1.22)	1.33 (1.35)	1.66 (1.47)	1.00 (1.22)
Polythene sheet at 8-10 DAS	0.66 (1.08)	1.33 (1.35)	1.00 (1.22)	0.66 (1.08)
Hand weeding (20 and 40 DAS)	1.33 (1.35)	2.33 (1.68)	2.66 (1.78)	2.00 (1.58)
Unweeded Control	5.33 (2.41)	6.33 (2.61)	6.66 (2.68)	5.66 (2.48)
CD (5%)	0.27	0.32	0.37	0.29
Chenopodium album				
Paddy straw (6 t ha^{-1}) at 8-10 DAS	1.33 (1.35)	1.66 (1.47)	1.33 (1.35)	1.00 (1.22)
Polythene sheet at 8-10 DAS	0.66 (1.08)	1.33 (1.35)	1.00 (1.22)	0.66 (1.08)
Hand weeding (20 and 40 DAS)	2.33 (1.68)	2.00 (1.58)	2.66 (1.78)	2.33 (1.68)
Unweeded Control	8.33 (2.97)	9.66 (3.19)	10.00 (3.24)	11.33 (3.44)
CD (5%)	0.43	0.46	0.47	0.49
Convolvulus arvensis				
Paddy straw (6 t ha^{-1}) at 8-10 DAS	1.33 (1.35)	1.66 (1.47)	1.33 (1.35)	1.00 (1.22)
Polythene sheet at 8-10 DAS	1.00 (1.22)	1.33 (1.35)	1.00 (1.22)	0.66 (1.08)
Hand weeding (20 and 40 DAS)	1.33 (1.35)	2.00 (1.58)	2.33 (1.68)	1.66 (1.47)
Unweeded Control	3.66 (2.04)	4.33 (2.20)	5.00 (2.35)	5.33 (2.41)
CD (5%)	0.26	0.23	0.28	0.31
Melilotus indicus				
Paddy straw (6 t ha^{-1}) at 8-10 DAS	1.00 (1.22)	1.66 (1.47)	1.33 (1.35)	1.00 (1.22)
Polythene sheet at 8-10 DAS	0.33 (0.91)	1.00 (1.22)	0.66 (1.08)	0.33 (0.91)
Hand weeding (20 and 40 DAS)	1.33 (1.35)	2.33 (1.68)	2.66 (1.78)	1.66 (1.47)
Unweeded Control	4.00 (2.12)	4.66 (2.27)	5.33 (2.41)	5.00 (2.35)
CD (5%)	0.28	0.24	0.27	0.31
Anagallis arvensis				
Paddy straw (6 t ha^{-1}) at 8-10 DAS	1.66 (1.47)	1.33 (1.35)	1.00 (1.22)	0.66 (1.08)
Polythene sheet at 8-10 DAS	0.33 (0.91)	1.00 (1.22)	0.66 (1.08)	0.33 (0.91)
Hand weeding (20 and 40 DAS)	1.33 (1.35)	1.66 (1.47)	2.00 (1.58)	1.00 (1.22)
Unweeded Control	3.00 (1.87)	3.66 (2.04)	4.33 (2.20)	5.00 (2.35)
CD (5%)	0.22	0.25	0.28	0.33
Rumex dentatus				
Paddy straw (6 t ha^{-1}) at 8-10 DAS	0.66 (1.08)	1.33 (1.35)	1.00 (1.22)	0.66 (1.08)
Polythene sheet at 8-10 DAS	0.33 (0.91)	1.33 (1.35)	1.00 (1.22)	0.33 (0.91)
Hand weeding (20 and 40 DAS)	1.00 (1.22)	2.00 (1.58)	2.66 (1.78)	2.33 (1.68)
Unweeded Control	4.66 (2.27)	5.33 (2.41)	6.00 (2.55)	6.33 (2.61)
CD (5%)	0.26	0.21	0.27	0.32
Coronopus didymus				
Paddy straw (6 t ha^{-1}) at 8-10 DAS	1.00 (1.22)	1.33 (1.35)	1.00 (1.22)	0.66 (1.08)
Polythene sheet at 8-10 DAS	0.66 (1.08)	1.33 (1.35)	1.00 (1.22)	0.33 (0.91)
Hand weeding (20 and 40 DAS)	1.66 (1.47)	2.00 (1.58)	2.33 (1.68)	1.66 (1.47)
Unweeded Control	4.33 (2.20)	4.66 (2.27)	5.66 (2.48)	6.33 (2.61)
CD (5%)	0.25	0.19	0.28	0.34
Other weed				
Paddy straw (6 t ha^{-1}) at 8-10 DAS	1.00 (1.22)	1.66 (1.47)	1.33 (1.35)	1.00 (1.22)
Polythene sheet at 8-10 DAS	0.66 (1.08)	1.00 (1.22)	1.33 (1.35)	0.66 (1.08)
Hand weeding (20 and 40 DAS)	1.66 (1.47)	2.00 (1.58)	2.33 (1.68)	2.00 (1.58)
Unweeded Control	4.00 (2.12)	5.33 (2.41)	6.66 (2.68)	6.33 (2.61)
CD (5%)	0.21	0.23	0.24	0.26
Total weed				
Paddy straw (6 t ha^{-1}) at 8-10 DAS	8.98 (3.08)	11.96 (3.53)	9.98 (3.24)	6.98 (2.73)
Polythene sheet at 8-10 DAS	4.63 (2.26)	9.65 (3.19)	7.65 (2.85)	3.96 (2.11)
Hand weeding (20 and 40 DAS)	11.97 (3.53)	16.32 (4.10)	19.63 (4.49)	14.64 (3.89)
Unweeded Control	56.23 (7.53)	62.80 (7.96)	72.70 (8.56)	75.14 (8.70)
CD (5%)	0.87	0.64	0.77	0.92

Table 3: Effects of paddy straw and polythene sheet mulching on weed index in wheat cv. K 1006

Treatment	Weed Index (%)
Paddy straw (6 t ha^{-1}) at 8-10 DAS	11.79
Polythene sheet at 8-10 DAS	6.72
Hand weeding (20 and 40 DAS)	3.49
Un-weeded Control	43.09

Conclusion

Based on the present findings, it is concluded that the black polythene sheet mulching was found better in comparison to paddy straw mulching, of course depending upon the weather, particularly rain falls during the crop duration. However, both mulching practices could be could be practiced in order to reduce the weed infestation significantly and sustaining the wheat productivity and profitability.

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