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EFFICACY OF RICE STRAW MULCH FOR THE CONTROL OF VECTOR AND VIRUS INCIDENCE IN POTATO

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The vector-virus complex in potato is managed mainly with the use of synthetic pesticides in addition to growing of seed crops during the low vector activity period and use of disease-free seed (Shah et al., 2020a). Other than environmental concerns, pesticides do not provide satisfactory control of the non-persistent viruses like *Potato Virus Y* (PVY), therefore alternatives for efficient management of the vector-virus complex are being continuously explored (Shah *et al*., 2019; 2020b). Among the alternatives is mulching of potato fields with cereal straw after planting. The efficacy of straw mulching against aphid and whitefly transmission of viruses has been reported in a wide range of crops, including potatoes (Saucke and Doring, 2004; Johnson *et al*., 2004; Kirchner *et al*., 2014; Dupuis *et al*., 2017). In India, potato is mainly cultivated in the Indo-Gangetic plains under short day conditions during winter following rice (Shah et al. 2020a). Therefore, there is ample quantity of rice straw available at potato planting.

Studies on the use of straw mulch have shown that fewer winged aphids are captured in mulched plots compared to non-mulched ones which could potentially lead to lower virus spread. Therefore, this study was undertaken to test how efficiently the rice straw mulch reduces the landing rate of aphids and whitefly on potato plants in comparison to non-mulched control and whether the incidence of potato viruses decreases in mulched plots. For this purpose, field experiments were conducted at ICAR-Central Potato Research Station, Jalandhar (Punjab) during *Rabi* 2020-21 in Randomised Complete Block Design, with seven treatments and three replications. Potato variety *Kufri Khyati* was grown in the experimental plots with recommended package of agronomic practices without any crop protection measures. Plating was done on 13th October, 2020 and haulms were cut on 08 Jan., 2021. Plot size of 3 × 3.2 m^2 was used for evaluating the mulches. Paddy straw was used either as chopped (5 – 7.5 cm) or un-chopped (30 - 45 cm) at 5 and 10 tons per ha, along with silver reflective mulch, black plastic mulch and un-mulched control. Mulches were applied two weeks after planting just before anticipated crop emergence.

The landing rate of aphids and whitefly was assessed using the weekly trap catch on yellow sticky traps (YST) throughout the crop growth period. Traps (22.8 × 15.2 cm) were installed within all the plots and

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replaced at weekly interval. Observations on the incidence of adult whiteflies and winged aphids on potato plants were taken from ten randomly selected plants per plot at weekly interval. The numbers were counted from three leaves on each plant, one each from upper, middle and lower strata. The total tuber yield in all the experiments was recorded on whole plot basis. Percent virus incidence (expressed as percentage of infected plants over total number of plants/plot) was noted one week before the haulms were cut. The data on trap catch and incidence of aphids and whiteflies was analysed with GLM using Poisson distribution and the treatments means were separated with Tukey's HSD test. All statistical analyses were done in R-software 4.0.0 (R Core Team, 2021).

The trap catches of aphids and whitefly, used as a measure of flight activity and landing rate on potato plants, indicated significant difference between the mulched and un-mulched plots. The trap catch of aphids was highest at crop emergence and decreased gradually afterwards while as that of whitefly increased for initial couple of weeks and decreased afterwards in the control plots (Fig. 1). The whitefly and aphid trap catch were lowest for silver reflective mulch, followed by rice straw mulch and black plastic mulch on most of the sampling dates. No significant difference was found between the chopped and non-chopped rice straw mulch plots or rice straw mulch plots applied @ 5 or 10 t/ha for both aphid and whitefly trap catch. Further, no significant difference was noted between the mulched and non-mulched plots after 4th week of deployment of the mulches.

The incidence of aphids and whitefly on potato plants indicated non-significant effect of mulches on most of the weekly samplings (Table 1). No significant difference was found among the treatments for the number of

Table 1: Effect of mulching on the incidence of aphids (various species) and whitefly, *Bemisia tabaci* on potato plants

Weeks after crop emergence	Parameters	Whitefly	Aphids
04-11-2020	*F* value	44.83	4.53*
	d.f.	6, 12	6, 12
	p (0.05)	< 0.01 (Significant)	0.01 (Significant)
11-11-2020	*F* value	3.16	1.84
	d.f.	6, 12	6, 12
	p (0.05)	0.04 (Significant)	0.17 (Not significant)
21-11-2020	*F* value	2.53	6.51
	d.f.	6, 12	6, 12
	p (0.05)	0.08 (Not significant)	< 0.01 (Significant)
28-11-2020	*F* value	1.27	2.35
	d.f.	6, 12	6, 12
	p (0.05)	0.33 (Not significant)	0.09 (Not significant)
05-12-2020	*F* value	0.79	1.41
	d.f.	6, 12	6, 12
	p (0.05)	0.59 (Not significant)	0.28 (Not significant)
11-12-2020	*F* value	0.74	1.09
	d.f.	6, 12	6, 12
	p (0.05)	0.62 (Not significant)	0.41 (Not significant)
26-11-2020	*F* value	3.49	0.61
	d.f.	6, 12	6, 12
	p (0.05)	0.03 (Significant)	0.71 (Not significant)

*Based on Robust regression.

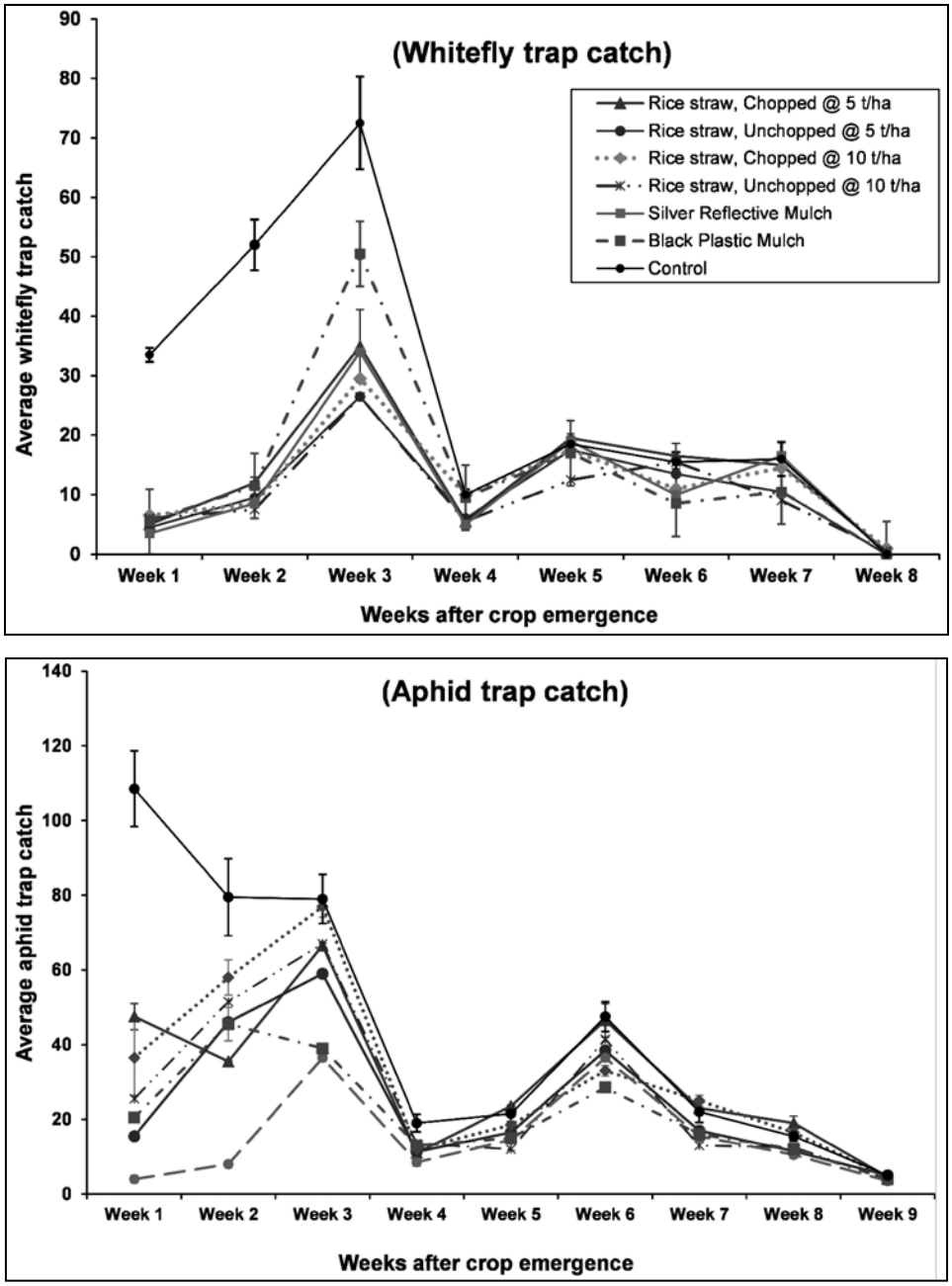

Fig. 1. Effect of different mulches on the landing rate of whitefly, Bemisia tabaci, and aphids (various species) in potato

aphids and whiteflies per plant although the incidence was close to half in the mulched plots as compared to non-mulched plots. The total tuber yield was found to vary from 32.53 to 34.30 t/ha with no significant difference among the treatments (Table 2). Considerable reduction in the incidence of virus symptomatic plants in the mulched plots was noted with significant effect of mulches (Table 2). The virus incidence reduced by 36.10 to 44.43 % in the mulched plots as compared to control (average virus infection 8.89 ± 1.57 % in control). The reduction in virus incidence was on par

Table 2: Effect of mulches on total tuber yield and virus incidence in potato

S. No.	Treatment	Tuber yield (ton/ha)	Reduction in Virus Incidence (%)
1.	Rice straw, Chopped @ 5t/ha	32.77	36.10 (6.03)
2.	Rice straw, Unchopped @ 5t/ha	32.53	38.90 (5.45)
3.	Rice straw, Chopped @ 10t/ha	33.70	44.43 (6.71)
4.	Rice straw, Unchopped @ 10t/ha	34.30	41.66 (6.46)
5.	Silver Reflective Mulch	32.87	36.10 (6.03)
6.	Black Plastic Mulch	32.77	36.13 (5.84)
7.	Control	32.73	0.00 (1.00)
8.	SEm	1.75	0.88
9.	CD (p = 0.05)	NA	2.74

Values in parenthesis are square root transformed as ×x + 1

among the mulched plots. Similar results were obtained from testing of random samples for the presence of viruses through DAS-ELISA and RT-PCR (data not shown).

The mode of action of cereal straw mulches is primarily attributed to the manipulation of the host finding behaviour of aphids by the visual properties of straw (Doring *et al*., 2005). According to a hypothesis proposed by Doring *et al*. (2005), aphids land indiscriminately on either the straw or the plant as a consequence of the low contrast between the plant and the straw background. However, once an aphid has landed on the straw and probed on it, it will take off again and leave the plot, starting the so called 'rejection flight'. Straw mulching is not effective during the whole growing periods; it is primarily effective from the emergence of the plants until the closure of the canopy (Heimbach *et al*., 2004; Saucke and Doring, 2004; Kirchner *et al*., 2014; Dupuis *et al*., 2017), as during this time the straw is visible for the winged aphids and thus has an effect on their landing behaviour. Afterwards, when the crop canopy covers the soil, the effect is lost. In the present study, we found that the effect of mulches on landing rate of the aphids and whitefly was non-significant after 4th week of crop emergence which coincides with the canopy closure of potato crop in the plains. Of particular interest is the non-significant variation in the incidence of aphids and whitefly on potato plants among the treatments. It seems like mulches reduce the number of insects landing on the plants however, the within plot spread is not affected.

Saucke and Doring (2004) used 3.5 t/ha of straw mulch and obtained an average efficacy of 31% (a 3-year trial in Germany) while Kirchner et al. (2014) used 5.5 t/ha with an efficacy of 44% (a 3-year trial in Finland). It is to be expected that a higher cover of the soil would better control aphid landings early in the season and better protect the plots against PVY spread. It is reported that 2.5 t/ha straw covers 60% of the soil at potato emergence and that it is the minimum quantity needed to reduce aphid captures in the crop (Dupuis *et al*., 2017). No significant difference in the aphid and whitefly trap catches was detected in this study between the plots mulched with rice straw at 5 and 10 t/ha; which is in coherence with the earlier reports. A virus reduction of 36.10 to 44.43 % in comparison to control was found in this study. Straw mulches have proven to be efficient in controlling PVY spread (Heimbach *et al*., 2004; Saucke and Doring, 2004). Kirchner *et al*., (2014) reported that 50-

70% lower incidence of PVY by using straw mulch, compared with untreated crops.

It has been shown that the initial colonization of potato fields by aphids tends to be concentrated on the margins of the fields (Carroll *et al*., 2009). We observed that the plants at margins of the mulched plants harboured higher number of aphids and whitefly (data not shown). It is suggested that the strong visual contrast provided by the fallow ground and the crop canopy might be more attractive to aphids than a homogeneous surface with relatively little contrast (Doring and Chittka, 2007). Therefore, it is advisable to mulch a plot 1 to 2 m beyond the plant line for best results.

It is concluded that rice straw mulch @ 5 t/ha can reduce the landing rate of aphids and whitefly considerably in potato crops. The mulches can provide protection to the crops for at least 4 weeks from crop emergence or till the canopy closure. Therefore, mulching can protect the crops from virus infection during early crop growth period when other methods of pest management are not very effective. Also, straw mulches can help to reduce the number of insecticide sprays needed and thus helps to protect the environment. It is suggested that rice straw mulching should be evaluated at multiple locations and on large scale over a number of seasons. Rice straw mulch has the potential for integration in to pest management program of seed potato crops, particularly where high value seed material is grown on small scale. Also, the use of rice straw mulch is compatible with organic potato cultivation.

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