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Effect of mulching on weed infestation and tuber yield of potato in black cotton soil

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ABSTRACT

A field experiment was conducted during winter months of 2003-04 and 2004-05 on a sandy clay loam black cotton soil to study the feasibility of using water hyacinth mulch for weed control and increasing productivity of potato cv. Kufri Chandramukhi. The weed control treatments consisted of control (no weed control measure), farmers practice (scrubbing the soil of inter rows space and earthing potato rows), water hyacinth mulch (HM), rice straw mulch (SM), metribuzin 250 g/ha as PE + HM, metribuzin 250 g/ha as PE + SM, metribuzin 500 g/ha as PE, and metribuzin 500 g/ha as PE + HM. Sprinkler irrigation was given immediately after planting, and flood irrigation was given during 3rd and 8th week after planting. Both rice straw and water hyacinth mulches controlled weed infestation throughout the growing period of potato, and no additional benefit of herbicide application in terms of weed control or tuber yield was noted in the mulched plots. The lowest tuber yield of 7.2 t/ha was recorded in control, it increased to 13.1, 20.8, 14.8, 21.1, 15.9, 13.0 and 21.4 t/ha respectively in the above mentioned treatments. It was concluded that water hyacinth mulch was superior to rice straw mulch in increasing potato yield in black cotton soil.

Key words : Potato, Weed, Rice straw mulch, Water hyacinth mulch, Black cotton soil

Water hyacinth (*Eichhornia crassipes* [Mart.] Solms-laubach) originating from South America, is ranked among the top ten weeds world wide. The seeds have been reported to remain viable in water bodies for up to 20 years. The rate of multiplication of water hyacinth is very high and due to its negative impact it is popularly known as 'Blue devil'. Water hyacinth is a big menace severely affecting navigation, fishing, recreational use of aquatic bodies and hydroelectric generation. It causes human health hazards by harbouring harmful insects and vectors of diseases like malaria, encephalitis, filariasis, *etc.* Manual removal of water hyacinth is the most widely practiced method of control in developing countries. Although the huge biomass thus obtained could be used as raw material for vermicompost, it requires additional physical structure for compost making and it involves additional transportation cost also. Directly using the dry water hyacinth biomass as mulch in the adjoining areas of its source of production could be an economically more viable means of its utilization. In terms of crop productivity water hyacinth mulch was found to be superior (Islam *et al*. 2002, Rahman and Khan 2002, Sannigrahi and Borah 2002, Tripathi *et al*. 1991) and as well as inferior (Baruah and Sarma 1996, Begum *et al*. 1998, Kotoky and Bhattacharyya 1996, Nath and Sarma 1992) to rice straw, which is a commonly used organic mulching material. The magnitude of mulch effect on nutrient supply and improvement on soil physical properties depends on the quantity and quality of mulch, soil properties and environment (Lal 1995). In view of this the present investigation was carried out to study the feasibility of using water hyacinth mulch for weed control and increasing productivity of potato in a black cotton soil.

MATERIALS AND METHODS

A field experiment was conducted during the winter season of 2003-04 and 2004-05 at NRCWS farm, Jabalpur, Madhya Pradesh. The soil of the experimental field was a black sandy clay loam with pH 7.25, EC 0.38 dS/m, organic carbon 7.5 g/kg, available P 14 mg/kg and available K 180 mg/kg. Water hyacinth was collected from a local pond and spread over the land to air dry it prior to be used as mulch. Rice straw used in the study was collected from NRCWS farm. The C:N ratio of water hyacinth and rice straw used in the given study was around 22:1 and 80:1, respectively.

Furrows with a depth of 5-6 cm were made in the experimental plots (5 m x 3 m) at an interval of 50 cm distance. Required amount of urea, SSP and MoP to supply N:P:K @ 100:100:100 kg/ha were uniformly applied and mixed with soil in the furrows, and then after planting of potato (cv. Kufri Chandramukhi) the furrows

were filled with soil to level the land, and subsequently irrigated using sprinklers. The weed control treatments were: T1: control (no weed control measure), T2: farmers' practice (scrubbing the soil of inter rows space and earthing potato rows), T3: water hyacinth mulch (HM), T4: rice straw mulch (SM), T5: metribuzin 250 g/ha as PE + HM, T6: metribuzin 250 g/ha as PE + SM, T7: metribuzin 500 g/ha as PE, T8: metribuzin 500 g/ha as PE + HM. Metribuzin was applied after three days of planting and mulching was done after 5-6 days of metribuzin application when the potato twigs started emerging out of the soil. Precaution was taken so that the potato twigs are not broken or covered up by the mulches. Each treatment was replicated four times and imposed by following RBD. Besides the initially given sprinkler irrigation, all the experimental plots received flood irrigation during 3rd and 8th week after planting. Observations were recorded on weed growth and tuber yield. Weed data was subjected to square root transformation for statistical analysis.

RESULTS AND DISCUSSION

The weedy plots were heavily infested with *Medicago denticulata* and *Physalis minima*, and moderately infested with *Chenopodium album*, *Vicia sativa* and *Chichorium antibum* during both the year of study. On an average a weed population of 453 /m^2 with a dry matter production of 77 g/m^2 was recorded in the weedy plots at 40 days after potato planting during 2003-04. No weed growth was noticed in the metribuzin alone (T7) plots at this stage of cropping. Similar observation was also recorded during 2004-05. However, the plots treated with metribuzin 500g alone (T7) showed the growth of weeds specially that of *Medicago denticulata* and *Vicia sativa* at later stage of cropping (Table 1). The total weed dry matter production at 75 DAP in the control (T1) and metribuzin alone plots (T7) were 144 and 105g/m^2, respectively, during 2004-05. Both rice straw (T4) and water hyacinth (T3) mulches alone as well as in combination with metribuzin (T5, T6, T8) fully controlled the weed infestation through out the cropping season during both the year of study. This indicated that the rice straw and water hyacinth mulches were more efficient than the application of metribuzin as a weed control measure, and there was no need of any herbicide application in the mulched plots of potato.

Table 1. Weed infestation at 75 DAP of potato

Treatments	Population (No/m^2)			Dry matter (g/m^2)
	Medicago	Vicia	Total	
Control	7.9 ± 0.6* ($62)$	3.9 ± 0.7 (15)	11.5 ± 0.4 (132)	11.9 ± 1.4 (143.7)
Metribuzin 500g PE	8.2 ± 1.0 (67)	5.8 ± 0.9 (36)	10.7 ± 0.7 (114)	10.2 ± 1.3 (105.4)

*Mean ± s.d.; figures in parenthesis are original values

The tuber yield data as recorded under different weed control treatments are given in Table 2. Significant increase in tuber yield in all the weed control treatments was recorded over the control, indicating the importance of weed control measure to obtain the higher level of potato yield. Compared to weedy treatment, earthing, metribuzin, rice straw mulch and water hyacinth mulch treatments increased tuber yield by respectively 1.53, 1.59, 2.09 and 2.54 times during 2003-04. There was no difference between the traditional practice of earthing the potato rows (T2) and the recommended pre-emergent application of metribuzin (T7) in terms of potato yield. However, the mulch treatments produced significantly higher potato yields than the conventional earthing as well as over the recommended metribuzin application. Compared to the traditional farmers practice of earthing (T2), potato yield was increased by 36.5% in case rice straw mulch (T4) and by 66.3% in case of water hyacinth mulch (T3). The well known beneficial effects of organic mulches on soil temperature and on conservation of soil moisture during the growing period could be the reason for obtaining higher potato yield under the mulches than the un-mulched plots. There was no difference between the rice straw mulch treatment (T4) and the rice straw mulch + metribuzin treatment (T6) in terms of potato yield. Similarly, there were no significant differences among the potato yields as recorded in the water hyacinth mulch treatment (T3) and water hyacinth mulch + metribuzin treatments (T5 and T8). No weed growth in the mulched plots, as mentioned above, could be the reason for obtaining no additional benefit of pre-emergent application of metribuzin in combination with rice straw mulch or water hyacinth mulch over the respective mulch treatments alone.

Table 2. Tuber yield of potato (t/ha) under different treatments during 2003-04 and 2004-05

Treatments	2003-04	2004-05	Pooled data
Control (T_1)	6.8	7.6	7.2
Earthing (T_2)	10.4	15.9	13.1
W/hyacinth (T_3)	17.3	24.2	20.8
Rice straw (T_4)	14.2	15.4	14.8
W/hyacinth + 1/2 Metribuzin (T_5)	17.8	24.3	21.1
Rice straw + 1/2 Metribuzin (T_6)	14	17.7	15.9
Metribuzin (T_7)	10.8	15.2	13.0
W/hyacinth + Metribuzin (T_8)	17.5	25.3	21.4
LSD (P=0.05)	2.6	3.2	

As during 2003-04, similar trend in the potato yield was observed during 2004-05 vis-à-vis given weed control treatments. Except that the rice straw mulch (T4), although it fully controlled weed during both the year of study, did not give any additional benefit in terms of potato yield over the traditional earthing practice (T2) and recommended metribuzin treatment (T7) during 2004-05. During 2004-05, there was around 100% increase in tuber yield in earthing, metribuzin and rice straw mulch treatments over the control. Whereas, the water hyacinth mulch treatment resulted in more than 200% increase in yield over control. Irrespective of the treatments, the average yield level obtained during 2004-05 was higher than that as recorded during 2003-04. Over the treatments, the average yield during 2003-04 was 13.6 t/ha and as indicated by paired-t test it was significantly lower than the average yield of 18.2 t/ha as recorded during 2004-05. It is pertinent to mention that the late blight disease appeared in the experimental plots after 85 days of potato planting during 2003-04. Although the recommended fungicide (mancozeb) was applied immediately at the onset of the disease, the proper control of blight was not obtained. The visual observation showed that intensity of the disease was much higher in the control, earthing and metribuzin alone treatments, that is in no mulch plots, compared to the mulched plots. Subsequently, the plants first started getting dried in the control, earthing and metribuzin alone treatments at around 105 days after planting; compared to this the drying of the potato plants was delayed by 6-7 days in the rice straw mulched plots. Drying of the potato plant was further delayed in the water hyacinth mulched plots and potato was finally harvested after 124 days of planting. However, there was no incidence of any disease during 2004-05. This could be the probable reason of obtaining lower yield during 2003-04 than in 2004-05 and why the rice straw mulch was superior to earthing and recommended metribuzin treatment during 2003-04 but not during 2004-05.

The yield data pooled over the years 2003-04 and 2004-05 showed that the lowest yield of 7.2 t/ha was recorded in weedy plots. Compared to this, the yield increased to 1.81, 1.82, 2.06 and 2.89 times in metribuzin alone (T7), earthing (T2), rice straw mulch (T4) and water hyacinth mulch (T3), respectively. Although both rice straw and water hyacinth mulches controlled the weed growth in potato during both the year of study, pooled data showed there was 40.5% increase in potato yield in water hyacinth compared to rice straw mulched plots. The much lower C:N ratio of water hyacinth (22:1) as compared to rice straw (80:1) could have favoured relatively rapid decomposition of the former in the interface between soil and mulch layer, and consequently the release of nutrients (Barman *et al*. 2006) from the decomposing water hyacinth mulch could have resulted in higher tuber yield in case of former than the later mulch. Razzaque and Ali (2009) reported that the different varieties of potato differed in their responses to rice straw and water hyacinth mulches under no tillage condition, but in general higher tuber yield was recorded under water hyacinth mulch. Differences in the effects of rice straw mulch and water hyacinth mulch on soil temperature and on water use efficiency by yellow sarson (*Brassica napus*) was earlier reported by Sarkar *et al.* (2007).

Overall, it was concluded that water hyacinth biomass could effectively be used as a mulching material in black cotton soil to control weed as well as to substantially increase potato yield over conventional mode of cultivation. Water hyacinth mulch was superior to rice straw mulch in increasing productivity of potato in this soil.

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