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Integration of weed management practices in rice-potato-groundnut cropping sequence

Md Riton Choudhury, Koushik Brahmachari, Sudeshna Kar and Rupayan Deb

Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur -741252, Nadia, West Bengal, India

E-mail: md.riton@gmail.com/ brahmacharis@gmail.com

A B S T R A C T

A field experiment was carried out at 'C' Block Farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia West Bengal in two consecutive years (2009-10 and 2010-11) to study the effect of different weed management measures (e.g. hand weeding, herbicides, mulching etc.) on the yield of crops in sequence and cost effectiveness of different weed control measures. Rice exhibited the maximum yield when treated with two hand weedings, but it may be profitably replaced by the application of herbicides. From the point of eco-safety measures and economy, combination of hand weeding and mulching can be judiciously recommended in potato and groundnut.

Keywords: Mulching, rice-potato-groundnut sequence, weed flora, weed management practices

Introduction

Crop diversification in a cropping sequence on the same piece of land may be a very important tool in increasing per ha net production from that very land. But in the era of global environmental perspective we cannot emphasize on our production need alone; we must consider the soil health to keep the sustainability of our production unaffected. Cultivation of huge nutrient mining crops like rice, potato etc may degrade the natural soil nutrient reserve. Under such condition, groundnut, being a leguminous crop would be one of the best choices for this cropping sequence. But to get some profitable return from a given cropping system, it is vital to keep the damage of the crop by various 'harmful agents' below the economic threshold level (ETL). Among these agents weeds contribute a significant interference to the normal crop growth and yield. With the increase of global temperature the weeds which are mostly of C_4 types will sustain in a better way due to increased rate of photosynthesis with decreasing photorespiration. On the other hand, the agricultural crops which are mostly of C_3 types will not be able to sustain properly due to decreased rate of photosynthesis with increasing photorespiration. As a result, the weeds gaining a competitive advantage dominate in the crop field. So, controlling weeds is an important thrust area of research in modern profit oriented farming. In order to get a weed free crop field, it is better to go for an integrated approach or to co-ordinate all the approaches suitable for the growers.

Materials and Methods

A field experiment was carried out in Gangetic alluvium soil (Entisol) having sandy clay loam texture with moderate soil fertility status (pH 6.74, organic carbon 0.57%, Total N 0.055%, available P_2O_5 26.29 kg ha^{-1}, avail-

able K_2O 148.72 kg ha^{-1}) during two consecutive years (2009-10 and 2010-11) at 'C' Block Farm (Latitude : 22°5′ N; Longitude: 89° E; Altitude: 9.75 m above the mean sea level) of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia West Bengal to study the integration of weed management practices in rice-groundnut-potato cropping sequence. The experiment was laid out in RBD with nine treatments replicated thrice. The crop wise treatment details are given below:

Treatments	Rice	Potato	Groundnut
T_1	Unweeded check	Unweeded check	Unweeded check
T_2	Hand weeding at 20 DAT	Hand weeding at 20 DAS	Hand weeding at 20 DAS
T_3	Hand weeding at 20 and 40 DAT	Hand weeding at 20 DAS and mulching	Hand weeding at 20 DAS and mulching
T_4	Butachlor @ 1.5 kg ha^{-1}	Metribuzin @ 0.60 kg a.i. ha^{-1}	Pendimethalin @ 1 kg a.i. a^{-1}
T_5	Pendimethalin @ 1.5 kg ha^{-1}	Quizalfop ethyl @ 1 kg a.i. ha^{-1}	Trifluralin @ 1 kg a.i. ha^{-1}
T_6	Oxadiargyl @ 0.1 kg ha^{-1}	Pendimethalin @ 1 kg a.i. ha^{-1}	Alachlor @ 1.5 kg ha^{-1}
T_7	Hand weeding at 20 DAT + Butachlor @ 1.5 kg ha^{-1}	Metribuzin @ 0.60 kg a.i. ha^{-1} + mulching	Pendimethalin @ 1 kg a.i. ha^{-1} + mulching
T_8	Hand weeding at 20 DAT + Pendimethalin @ 1.5 kg ha^{-1}	Quizalfop ethyl @ 1 kg a.i. ha^{-1} + mulching	Trifluralin @ 1 kg a.i. ha^{-1}+ mulching
T_9	Hand weeding at 20 DAT + Oxadiargyl @ 0.1 kg ha^{-1}	Pendimethalin @ 1 kg a.i. ha^{-1} + mulching	Alachlor @ 1.5 kg a.i. ha^{-1}+ mulching

*All the herbicides were applied as pre-emergence

The weed control efficiency and weed index were calculated with the following formulas;

$$\text{Weed control efficiency (\%)} = \frac{X - Y}{X} \times 100$$

where, X = Weed dry weight in control (untreated/unweeded) plot,

Y = weed dry weight in treated plot

Weed index is an index expressing the reduction in yield due to the presence of weeds in comparison with weed-free situation.

$$\text{Weed index (\%)} = \frac{X - Y}{X} \times 100$$

Where, X = Grain yield from weed free (hand weeding) treatment,

Y = Grain yield from treatment for which weed index is to be worked out.

Results and Discussion

Some of the predominant weeds of rice were *Echinochloa colonum, Echinochloa crusgali, Paspalum disticum*; of potato were *Fumaria parviflora, Anagalis arvensis, Chenopodium album;* and of groundnut were *Cyperus rotundas, Digera arvensis*. The result supports the findings of Bahar *et al.* (2004). The data depicted in the table1 represent the weed control efficiency in percentage (WCE) and weed index (WI) of rice, potato and groundnut respectively. In rice at 30 DAT the highest weed control efficiency (88.66%) was obtained in the treatment T_9 (HW at 20 DAT + Oxadiargyl @ 0.1 kg ha^{-1}). At 60 DAT and harvest hand weeding at 20 and 40 DAT surpassed all the other methods of weed management in respect of weed control efficiency (83.48% and 75.49%, respectively). The calculated weed indices of different treatments revealed that unweeded control treatment (T_1) recorded the highest weed indices (47.66), whereas, the lowest indices (5.91) were registered in the treatment T_9 (HW at 20 DAT + Oxadiargyl @ 0.1 kg ha^{-1}). Similar results were reported by Bali *et al.* (2006).

In potato, the treatment T_3 (HW at 20 DAP + Mulching) manifested the best performance with respect to the WCE at 30 & 60 DAP. But at later stage the treatment T_7 (Metribuzin @ 0.6 kg a.i. ha^{-1} + Mulching) was found to be best. This may be due to eradication of weeds by hand weeding and suppressing the same by mulching resulting high mortality of weeds. But at the later stage the weed growth was checked due to the combined impact of herbicides and mulching. Practically, they had unique combined effect in weed killing and weed suppressing. The WI values were found to be significant in response to varying weed management practices. However, the crop receiving no weed control measures (T_1) recorded the highest one and the crop treated with Quizalfop ethyl @1 kg a.i. ha^{-1} + Mulching i.e. T_8 recorded the lowest WI value. Likewise the two other crops, the unweeded plot had to face severe weed crop competition for growth factors. Dua (2000) and Datta *et al.* (2003) also found similar results. In Groundnut, the crop receiving HW at 20 DAS + Mulching (T_3) showed the highest values of WCE at all the growth stages. This may be due to the suppression of early weed growth by adoption of hand weeding with mulching. The unweed control plot (T_1) recorded the highest WI where as the crop receiving Trifluralin @ 1 kg a.i. ha^{-1} + Mulching i.e. T_8 recorded the lowest value. This may be due to uncontrolled weed growth in unweeded plot resulting severe weed-crop competition. On the other hand application of herbicide along with mulching helped to check the weed growth. Kar and Kar (2003) also reported similar results.

The results illustrated in Table 2 depict the yield of rice, potato and groundnut. From the pooled analysis it is evident that all the weed management practices increased the grain yield of rice significantly over unweeded control. Hand weeding twice at 20 and 40 DAT produced the maximum grain yield

(4.45t ha^{-1}) of rice. Amongst the combined treatments and sole herbicidal treatment, combination of hand weeding and chemical herbicides produced better result. Combination of hand weeding at 20 DAT and Oxadiargyl @ 0.1 kg ha^{-1} was found to be superior amongst the combined treatments. Similar results were also noticed by Attla *et al*. (2002). The crop managed with HW at 20 DAP + Mulching i.e. T_3 produced the highest tuber yield (28.72tha^{-1}) and closely followed by that (28.60tha^{-1}) shown by the crop receiving Quizalfop ethyl @1 kg a.i. ha^{-1} + Mulching i.e., T_8. This is also to be noted that the above mentioned two treatments i.e., T_3 and T_8 are statistically at par with each other. This may be due to the combination of hand weeding with mulching resulting tremendous weed suppression effect. On the other hand combination of herbicide and mulching resulted in less weed infestation. Dua (2000) and Jaiswal (1993) also found similar results in this aspect. The pooled data clearly shows that the treatment T_3 i.e. HW at 20 DAS + Mulching produced the maximum pod yield (2.24tha^{-1}) in comparisons to other treatments. This may be due to the fact that the crop weed competition less in that plot due to hand weeding with mulching. This result is in agreement with the findings of Velu *et al.* (1994) and Datta *et al.* (2001). The treatment T_8 (Trifluralin @ 1 kg a.i. ha^{-1} + Mulching) and T_9 (Alachlor @ 1.5 kg a.i. ha^{-1} + Mulching) also performed better than other treatments and they are found to be statistically at par with each other. This may be due to less infestation of weeds through integrated weed management. This result is an agreement with the findings of Patel *et al.* (1990) and Kar and Kar (2003).

The figure 1 representes the return per rupee invested. In case of rice, the treatment T_9 (HW at 20 DAT + Oxadiargyl @ 0.1 kg ha^{-1}) recorded the highest value (1.96) and it was followed by the treatment T_7 (HW at 20 DAT + Butachlor @ 1.5 kg ha^{-1}) registering the value of 1.91. Attla *et al.* (2002) found similar result. In potato, the maximum return per rupee invested (3.81) was obtained from the crop receiving hand weeding at 20 DAP with Mulching (T_3) and it was closely followed by the treatment T_8 (3.61) and treatment T_9 (3.59).This is due to the maximum grain yield with lower cost of cultivation obtained from the Treatment T_3 i.e. hand weeding at 20 DAP with mulching. This result is in agreement with the findings of Datta *et al.* (2003). Likewise in groundnut, use of Trifluralin or Alachlor with mulching reduced the cost of hand weeding as well as total cultivation cost as compared to other treatments ensuring satisfactory gross return and returns per rupee investment. The findings are in agreement with the opinions of Dharkar (2000), Ghosh (2002) & Manickam (2000).

The applied weed control treatments significantly improved the yield components which ultimately led to rise in the yield of all the crops in sequence i.e., rice, potato and groundnut over control. In case of rice though the yield was maximum under the treatment comprising of two hand weedings at 20 and

40 DAS (T_3), such bulky, laborious, time consuming and costly mechanical method could easily be replaced by the application of Oxadiargyl @ 0.1 kg ha^{-1} most economically In case of potato the tuber yield *vis-à-vis* return per rupee invested were found maximum under the treatment T_3. The treatment T_8 and T_9 performed almost equally as good as the best treatment i.e., T_3. In case of groundnut the pod yield *vis-à-vis* return per rupee invested were found maximum under the treatment T_3 though economically the treatment T_8 and T_9 were almost at par with it.

From the point of eco-safety measures, combination of hand weeding and mulching can judiciously be recommended to the potato growers as mulching enhances tuber growth by maintaining soil health and hand weeding improves tuber growth by loosening the soil properly. The findings of the experiment provide us with a great opportunity of using herbicides along with mulching to manage the labour crisis due to heavy engagement of labourers in jute during this pre-*kharif* groundnut season. At the same time mulching can also help in conserving soil moisture and nutrient as an important tool of resource conservation technology.

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Table 1.
Effect of different weed management practices on weed control efficiency in rice-potato-groundnut cropping sequence

Treatments	Weed control efficiency (%)									Weed index (%)		
	Rice			Potato			Groundnut			Rice	Potato	Groundnut
	30	60	harvest	30	60	harvest	30	60	Harvest			
T_1	-	-	-	-	-	-	-	-	-	47.66	24.87	28.62
T_2	83.30	41.24	39.83	36.23	27.62	23.51	36.86	33.58	23.99	27.10	25.08	26.91
T_3	84.25	83.48	75.49	74.55	79.91	49.24	87.88	76.06	68.10	0.00	0.00	0.00
T_4	71.34	55.92	48.78	45.22	55.71	42.17	46.44	31.16	38.68	30.53	22.11	22.51
T_5	65.06	47.96	37.74	38.17	51.34	40.23	31.54	36.01	30.28	26.16	25.08	24.42
T_6	74.99	61.99	51.76	41.90	45.86	32.06	48.27	29.82	28.20	12.15	14.93	18.29
T_7	86.49	73.53	64.70	65.83	73.85	61.05	61.04	51.26	54.78	17.44	10.93	15.37
T_8	83.09	66.36	58.27	25.17	63.78	55.77	44.75	57.60	41.61	8.72	5.52	9.84
T_9	88.66	76.39	69.42	48.82	57.56	45.28	60.71	53.17	50.00	5.91	7.12	11.09

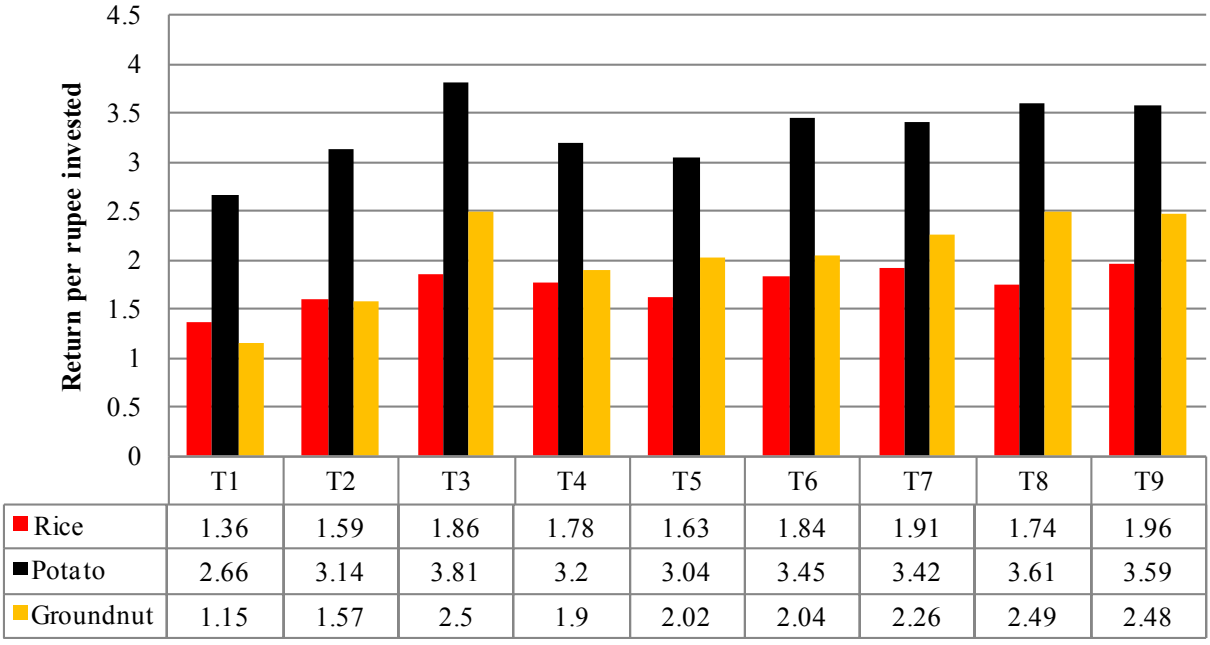
T_1-T_9 represents the represents the treatment combinations of these crops separately

Table 2.

Yield of rice, potato and groundnut in different weed management practices

Treatments	Rice (t ha^{-1})	Potato (t ha^{-1})	Groundnut (t ha^{-1})
T_1	2.50	19.95	0.92
T_2	3.08	24.24	1.36
T_3	4.45	28.72	2.24
T_4	3.52	25.0	1.56
T_5	3.35	22.66	1.66
T_6	3.55	25.59	1.64
T_7	4.24	26.88	1.77
T_8	4.08	28.60	2.09
T_9	4.33	26.43	2.16
S Em ±	0.03	2.479	0.02
CD (P=0.05)	0.09	6.437	0.07

T_1-T_9 represents the represents the treatment combinations of these crops separately



	T1	T2	T3	T4	T5	T6	T7	T8	T9
Rice	1.36	1.59	1.86	1.78	1.63	1.84	1.91	1.74	1.96
Potato	2.66	3.14	3.81	3.2	3.04	3.45	3.42	3.61	3.59
Groundnut	1.15	1.57	2.5	1.9	2.02	2.04	2.26	2.49	2.48

Fig 1. Return per rupee investment