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Influence of weed management practices on nutrient uptake by weeds and crop in transplanted rice

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Abstract

Among the production constraints weed infestation has been recognized as major one, resulting in about one third reduction in crop yields. Herbicides have become a popular choice amongst the farmers for managing weeds in almost all the crops. However with the increasing incidences of herbicide resistance, use of herbicides alternately or in mixtures has been recommended. Keeping this in mind the present experiment was conducted at the Experimental Farm of CSKHPKV, Rice and Wheat Research Centre, Malan during *khariif* seasons of 2015 and 2016 to evaluate the influence of weed management practices on nutrient uptake by weeds and crop in transplanted rice. Results of the study revealed that significantly highest uptake of all the three major nutrients (NPK) by rice was recorded with the application of penoxsulam + butachlor @ 717.5 g ha⁻¹ though this treatment was at par with all other herbicide treatments except in treatment where butachlor was applied as well as weed free treatment while lowest uptake of all the major nutrients was recorded in weedy check plot. Nutrient uptake by the crop followed the trend of the grain yield. As for the nutrient uptake by weeds is concerned, significantly higher uptake of all the three nutrients was recorded from the weedy check while significantly lowest uptake was from weed free treatment. Amongst different herbicide treatments lowest uptake by weeds was recorded with penoxsulam + butachlor @ 717.5 g ha⁻¹ though it was at par with all other herbicide treatments except butachlor @ 1500 g ha⁻¹.

Keywords: Transplanted rice, nutrient uptake, herbicides, Penoxsulam + butachlor

Introduction

Rice (*Oryza sativa* L.) forms staple food for more than half of the world's population (Prashanth *et al.* 2016) [7]. About 90 per cent of total rice is grown and consumed in Asia. Globally this crop ranks first in area and second to wheat in grain production. Among the production constraints weed infestation has been recognized as major one and yield reduction due to crop weed competition in transplanted rice has been reported to be 28 to 45 per cent (Singh *et al.* 2003) [9]. Weeds compete for different resources (space, water, nutrients and carbon dioxide) with the crop and lower the availability of these resources to the crop resulting in reduced yields. Controlling weeds satisfactorily increases the cost of cultivation of the crop as well as deplete resource base (Buriro *et al.* 2003) [1]. Still, their menace is often ignored because the losses they cause are not visible to human eye. But the fact remains that the weeds directly reduce the crop yields and indirectly they increase farm production costs through energy spent in controlling them. Weeds in general, are controlled either using herbicides or are managed manually or mechanically. However manual weeding is becoming less common because of non-availability of labour at critical times and increased labour cost. Further manual weeding can be performed only when weeds have reached a sufficient size to be pulled out easily by hand. By that time, yield losses may have already occurred. It is, therefore, essential to find out the alternative practices for managing the menace of weeds. Herbicides are the largest growing segments accounting for about 16 per cent of total crop protection chemicals market (Sharma *et al.* 2017) [8]. Use of herbicides has been found promising for managing weeds in different crops (Chauhan *et al.* 2014) [2]. Of late there are reports of development of herbicide resistance in weeds.

To check this problem of herbicide resistance it is essential to use number of herbicides alternately or use herbicide mixtures that have different mechanism of action. This alternate use of herbicides having different mechanisms of action will contribute to the sustainable weed management.

Material and methods

The study was conducted during *kharif* seasons 2015 and 2016 at the Experimental Farm of CSKHPKV, Rice and Wheat Research Centre, Malan. Agro climatically, the experimental site falls under sub-temperate humid zone of Himachal Pradesh which is characterized by mild summers and cool winters. Variety HPR 2143 of transplanted rice was grown with recommended package of practices. Eight weed control treatments *viz.*, penoxsulam + butachlor @ 717.5 g ha⁻¹ and 820 g ha⁻¹ (7 days after transplanting, DAT), penoxsulam @ 25 g ha⁻¹ (8-12 DAT), butachlor @ 1500 g ha⁻¹ (1-3 DAT), bispyribac sodium @ 25 g ha⁻¹ (20 DAT), weed free condition, hand weeding twice (25 & 45 DAT) and weedy check were evaluated in randomized block design with three replications. The herbicides and intercultural operations were applied as per the treatment to different plots. Herbicides were applied with backpack knapsack sprayer using 750 litres of water per hectare. Nutrient uptake by weeds was determined at maximum dry matter accumulation stage (75 DAT) while those by the crop was estimated with the final yields (grain and straw) after the harvest of the crop. Samples were collected, dried in oven at 70 °C till constant weight, then grounded and stored in paper bags for further analysis. The oven dried samples were analyzed for nitrogen,

phosphorus and potassium content using methods outlined by Li (1966)^[3] and uptake calculated. The data so obtained from field as well as laboratory were subjected to statistical analysis as per procedure given by Gomez and Gomez (1984)^[4].

Results and Discussion

Nutrient uptake by weeds

The dry matter accumulation by weeds at maximum accumulation stage was significantly affected by various weed control treatments with significantly lowest and highest values recorded from weed free and weedy check, respectively (Table 1). Amongst the herbicide treatments lowest dry matter accumulation was recorded with the application of new herbicide combination product penoxsulam + butachlor 820 g ha⁻¹ though it was at par with all other herbicide treatments except butachlor 1500 g ha⁻¹ indicating the effectiveness of these herbicides for managing weeds in transplanted rice. The trend similar to the dry matter accumulation by weeds was also observed for the nutrient uptake by weeds with significantly highest uptake of nitrogen (7.12 kg ha⁻¹), phosphorus (0.97 kg ha⁻¹) and potassium (17.29 kg ha⁻¹) uptake recorded in weedy check treatment. Significant lowest uptake of all the three nutrients were recorded from weed free treatment though it was at par with hand weeding twice and application of new combination product having penoxsulam and butachlor at both the doses. The effectiveness of hand weeding and herbicides in reducing nutrient depletion by weeds in rice has also been reported by several workers (Gopinath *et al.* 2012 and Nath *et al.* 2014)^[5, 6].

Table 1: Effect of weed control treatments on dry matter accumulation and nutrient uptake by weeds in transplanted rice (pooled data of two years)

Treatment	Dose (g ha ⁻¹)	Time of application	Dry matter accumulation (75 DAT) (g m ⁻¹)	Nutrient uptake by weeds (kg ha ⁻¹)		
				Nitrogen	Phosphorus	Potassium
Penoxsulam + Butachlor	717.5	7 DAT	4.62(20.08)	1.25(1.06)	0.81(0.16)	1.75(2.55)
Penoxsulam + Butachlor	820	7 DAT	4.47(19.5)	1.24(1.05)	0.81(0.16)	1.74(2.52)
Penoxsulam	25	8-12 DAT	5.57(30.6)	1.45(1.59)	0.86(0.24)	2.11(3.93)
Butachlor	1500	1-3 DAT	6.82(46.0)	1.68(2.32)	0.91(0.33)	2.53(5.92)
Bispyribac sodium	25	20 DAT	5.20(26.5)	1.37(1.38)	0.83(0.19)	1.97(3.40)
Weed free condition (25, 45 and 75 DAT)	-	-	3.27(10.2)	1.00(0.50)	0.76(0.08)	1.33(1.26)
Hand weeding twice (25 and 45 DAT)	-	-	3.66(12.9)	1.07(0.64)	0.77(0.09)	1.46(1.63)
Weedy check	-	-	12.02(143.9)	2.76(7.12)	1.21(0.97)	4.22(17.29)
SE (m±)			0.50	0.10	0.02	0.16
CD (P=0.05)			1.42	0.29	0.06	0.46

*Figures in parentheses are the means of original values, data analysed after square root transformation

Yield

Competition caused by weeds in weedy check significantly lowered the grain yield of rice as compared to all other treatments. Significantly highest grain yield was recorded with the application of penoxsulam + butachlor 717.5 g ha⁻¹ though it was at par with weed free treatment and all other herbicide treatments except butachlor 1500 g ha⁻¹. Similar trend was also observed with respect to straw yield of rice (data not given).

Nutrient uptake by crop

The data on effect of different weed control treatments on the nutrient uptake by rice crop (grain and straw) has been given

in Table 2. Application of penoxsulam + butachlor 717.5 g ha⁻¹ resulted in significantly higher uptake of all the three nutrients (nitrogen, phosphorus and potassium) though this treatment was at par with weed free, penoxsulam + butachlor 820 g ha⁻¹ and penoxsulam 25 g ha⁻¹. Significantly lowest uptake of all the nutrients was recorded in weedy check treatment. Better control of weeds in treatments where other herbicides were applied or weeds removed manually through hand weeding resulted in lower crop-weed competition and higher yields. Since the nutrient uptake is a function of the grain and straw yield and nutrient concentration in grain and straw, these treatments resulted in higher uptake of all of these nutrients.

Table 2: Effect of weed control treatments on grain yield and nutrient uptake by transplanted rice (pooled data of two years)

Treatment	Dose (g ha ⁻¹)	Time of application	Grain yield (kg ha ⁻¹)	Nutrient uptake (kg ha ⁻¹)		
				Nitrogen	Phosphorus	Potassium
Penoxsulam + Butachlor	717.5	7 DAT	5003	84.83	16.40	75.23
Penoxsulam + Butachlor	820	7 DAT	4888	79.08	15.92	74.95
Penoxsulam	25	8-12 DAT	4743	79.35	15.36	69.51

Butachlor	1500	1-3 DAT	4511	74.97	14.65	66.59
Bispyribac sodium	25	20 DAT	4682	76.03	14.72	72.14
Weed free condition (25, 45 and 75 DAT)	-	-	4828	79.19	15.50	72.89
Hand weeding twice (25 and 45 DAT)	-	-	4443	72.48	15.10	66.92
Weedy check	-	-	3291	52.53	10.62	49.94
SE (m±)			124	2.27	0.52	2.11
CD (P=0.05)			357	6.58	1.53	6.08

The nutrient uptake by crops was inversely proportional to nutrient uptake by weeds. Increase in nutrient uptake by crop as a result of decrease in crop-weed competition has also been reported by Singh *et al.* (2003)^[9]. Higher nutrient uptake by crop was mainly attributed to lower weed population and weed dry weight and this has helped the crop to grow well and absorb more nutrients from the soil. These results are in line with those obtained by Sunil *et al.* (2011)^[10].

Conclusion

Results of the study revealed that significantly highest uptake of all the three major nutrients (NPK) by rice was recorded with the application of penoxsulam + butachlor @ 717.5 g ha⁻¹ though this treatment was at par with all other herbicide treatments except butachlor and bispyribac sodium as well as weed free treatment while lowest uptake of all the major nutrients was recorded in weedy check plot. Nutrient uptake by the crop followed the trend of the grain yield. As for the nutrient uptake by weeds is concerned, significantly higher uptake of all the three nutrients was recorded from the weedy check while significantly lowest uptake was from weed free treatment. Amongst different herbicide treatments lowest nutrient uptake by weeds was recorded with penoxsulam + butachlor @ 717.5 g ha⁻¹ though it was at par with all other herbicide treatments except butachlor @ 1500 g ha⁻¹.

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