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EFFECTS OF SOWING TIME AND WEED MANAGEMENT PRACTICES ON WEED DYNAMICS, PRODUCTIVITY AND QUALITY OF DIRECT SEEDED BASMATI RICE

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Abstract

The crop grown on 15th June showed significantly lower total weed density and weed dry weight in direct seeded basmati rice. Amongst weed management options, post-emergence application of bispyribac @ 30 g/ha recorded significantly lower total weed density, weed dry matter, weed index and higher weed control efficiency which led to significant enhancement in grain and straw yield of rice. Post emergence application of bispyribac @ 30 g/ha resulted in improving the quality of basmati rice and significantly lower amylose content and more water uptake while cooking was observed. The highest net returns (Rs. 84568/ha) and B: C ratio (3.46) were recorded with the post emergence application of bispyribac @ 30 g/ha.

Introduction

Rice is a principal source of food for more than half of the world population, and more than 90% of rice worldwide is grown and consumed in Asia. It occupies approximately 161.1 m ha area globally, of which 138 m ha in Asia (Upasani *et al.*2016) Traditionally, rice in India is established through transplanting (25 - 30 days old seedlings) into a puddle paddy field, making it cumbersome, costly and labor intensive. Continuous flooding for rice cultivation is not only a huge drain on already scarce freshwater resources, but often results in lower water productivity. Looming water crises, rising wage rates, and the stagnant productivity of the rice-wheat cropping system have compelled researchers and farmers to seek alternative methods of rice establishment (Mahajan and Chauhan 2011, Chauhan *et al*. 2012). Dry-seeded rice (DSR) is a potential alternative that can help to improve water productivity, and eliminate time and edaphic conflicts in the rice-wheat cropping system (Khaliq *et al*. 2011). Moreover if some sort of shortening in rice crop duration is achieved, the next crop *viz.* wheat can be timely planted which usually gets delayed due to late ripening of fine rice. Growing of rice under aerobic conditions can reduce water losses to a great extent during hot summer months (May-June). The water resources both under surface and water is becoming a limiting factor. Hence, direct seeding of rice instead of conventional transplanting to reduce water losses is being practiced. The time of sowing has noticeable impact on weed intensity and probably on yield also. Delay in sowing results in slow growth of crop and increased infestation of competing weeds. Therefore, the sowing time of direct seeded rice needs to be assessed precisely so as to enable the rice crop in utilizing the growing degree days and heat units optimally for achieving magnitudes which are at least at par with those attained through transplanting method of establishment.

There are a few limiting factors associated with direct seeded rice that impair yields including crop-weed competition. Compared to transplanted rice, the yield losses in direct seeded rice is greater due to absence of flooding water at the early stage of the crop to suppress weed growth

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(Singh *et al*. 2007). Despite weed management, yield loss (10 - 20%) in lowland rice could be higher if weeds are not controlled. It has been estimated that yield loss in rice could be high (60 - 74%) due to weed infestations (Akbar *et al*. 2012). It has been estimated that yield loss (17 - 24%) would be higher in direct seeded rice when weeds were allowed to compete until 4 weeks after seeding (Chauhan and Johnson 2011). As regards the various weed management measures, manual eradication has proved its superiority over all the measures in managing weeds, however the adoption of this technique is not gaining popularity amongst the rice growers as it is time consuming, labor intensive and many times become impractical because of scarcity of labour. Timely weeding is most important to minimize yield losses and therefore under such circumstances the only effective tool is left to control weeds through the use of chemicals. Management of weeds through the use of chemicals has also been found as effective as realized under manual eradication in various crops including rice with over and above benefits in saving extra costs involved in use of labor on manual eradication of weeds Therefore, keeping the weeds below threshold level, herbicides provide the cheapest and effective tool through which excessive weed population can be controlled before crop-weed competition. Hence, keeping the above facts in view, the present investigation was undertaken to assess the times of sowing and weed control measures for improving the productivity in direct-seeded aromatic rice in foot hills of J&K Himalayas.

Materials and Methods

A field experiment was conducted at the research farm of Division of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu during *Kharif* 2012 and 2013. The experimental soil was sandy clay loam in texture medium in organic carbon (5.4 g/kg) available phosphorus (11.26 kg/ha) and potassium (146.2 kg/ha) but low in available nitrogen (245.7 kg/ha). The experiment was conducted in spilt plot design with three replications. The main plot treatments consisted of two times of sowing, (i) 15 June and (ii) 10 July while the sub-plot treatments were comprised of seven methods of weed control practices (i) azimsulfuron 35 g/ha post-emergence (20 DAS), (ii) cyhalofop butyl + 2,4-D 90 g/ha + 500 g/ha post-emergence (30 DAS) (iii) bispyribac 30 g/ha post-emergence (30 DAS), (iv) anilophos + ethoxysulfuron 375 g/ha + 15 g/ha post-emergence (15 DAS), (v) oxadiargyl 100 g/ha pre-emergence, (vi) weedy check and (vii) weed free. Rice cultivar 'Basmati-370' was sown at row to row spacing of 20 cm using 40 kg seed/ha. The crop was fertilized with NPK at 30, 20 and 10 kg/ha. Full dose of phosphorus and potassium along with one third of nitrogen were applied as basal dose at the time of sowing and remaining two third of nitrogen was applied in two equal splits, one third at tillering stage and the one third was applied at panicle initiation stage. Pre- and post-emergence herbicides were sprayed by knapsack sprayer fitted with flat fan nozzle using a spray volume of 500 l/ha. Weedy check plots remained infested with native population of weeds till harvest. Data on weed population and weed dry matter, yield attributes and yield were recorded. The data on weeds were subjected to square root transformation ($\sqrt{X+1}$) to normalize their distribution. Weed indices like weed control efficiency was calculated as suggested by Mishra and Mishra (1997) and weed index was calculated as suggested by Raju (1998). Quality parameters *viz.* amylose contrent (Juliano 1971) and water uptake while cooking (Biswas and Juliano 1988) were estimated as per the standard method. The data obtained on various parameters *viz.* weed count, weed density, yield attributes and yield, quality parameters were tabulated and subjected to analysis of variance techniques as described by Cochran and Cox (1963). The key for degree of freedom used in analysis of variance is given below.

Source of variation	Degree of freedom
Replications (r-1)	3 - 1 = 2
Main plot (A-1)	2 - 1 = 1
Error (a) = (r-1) (A-1)	(3 - 1)(2 - 1) = 2
Sub plot (B-1)	7 - 1 = 6
Main plot (A-1) × Sub plot (B-1)	(2 - 1)(7 - 1) = 6
Error (b) = A(r-1) (B-1)	2 x 2 x 6 = 24
Total (rab-1)	42 - 1 = 41

Results and Discussion

The major weeds in the experimental field were *Cynodon dactylon* (L.) Pers., *Echinochloa crus-galli* (L.) Beauv., *Commelina benghalensis* L., *Cyperus rotundus* L., *Cyperus difformis* L., *Ammania baccifera* L. and other minor species *viz. Eclipta alba* (L.) Hassk. and *Solanum nigrum* L. The grassy weeds dominated the weed flora throughout the crop growth seasons during the years of cropping (Fig. 1). Among times of sowing, crop sown on 15th June recorded significantly lowest density of all weed species density of weeds at harvest as compared to crop sown on 10th July (Table 1). Consequently, weed dry matter of all weed species at harvest in 10th July sown crop was significantly highest than 15th June sown crop. This might have happended due to relatively conducive environment with development of greater amount of foliage leading to enhanced weed suppression and better utilization of natural resources which inhibited the germination of weed seeds and growth of weed. This might have also due to relatively conducive environment for ensuring better germination and initial plant stand with development of greater amount of foliage providing better smothering capacity to crop plants leading to enhanced weed suppression. This suppression provided an opportunity to crop plants to better utilize the natural resources in the vicinity with lower light transmission ratio at the ground level which inhibited the germination of weed seeds and growth of weed. This observations are in agreement with the findings of Jadhav (2013) and Chalka and Sinha (2013). Among weed management practices, significantly lowest total weed density of all weed species at harvest was recorded with application of bispyribac @ 30 g/ha which was found to be statistically at par with post emergence application of cyhalofop-butyl + 2,4-D @ 90 g/ha + 500 g/ ha and anilophos + ethoxysulfuron @ 375 g/ha + 15 g/ha. Further post emergence application of bispyribac @ 30 g/ha also showed significantly lowest weed dry matter of all weed species which was closely followed by cyhalofop-butyl + 2,4-D @ 90 g/ha + 500 g/ha and anilophos + ethoxysulfuron @ 375 g/ha + 15 g/ha. Better efficacy and prolonged effectiveness of applied herbicides which did not allow the weeds to germinate and even resulted in rapid depletion of carbohydrate reserves of weeds already germinated through rapid respiration, senescence of leaves, reduction in leaf area and diminution of photosynthesis process (Singh *et al*. 2013). Basmati rice direct-seeded on 15th June showed highest weed control efficiency (60.54%) at harvest as compared to rice sown on 10th July. Among weed control methods, post-emergence application of bispyribac @ 30 g/ha (72.84%) was superior followed by post-emergence application of cyhalofop-butyl + 2, 4-D @ 90 g/ha + 500 g/ha and anilophos + ethoxysulfuron @ 375 g/ha + 15 g/ha. Lowest weed index was also recorded following the post emergence application of bisypyribac @ 30 g/ha followed by post-emergence application of cyhalofop-butyl + 2,4-D @ 90 g/ha + 500 g/ha and anilophos + ethoxysulfuron @ 375 g/ha + 15 g/ha in the increasing order (Table 2). Kumar *et al.* (2013) had reported similar findings.

Table 1. Effect of sowing time and weed management practices on total weed count, total weed dry weight, weed control efficiency and weed index of direct seeded basmati rice.

Treatment	Species wise weed count						Species wise weed dry weight					
	E. crusgalli	*C. dactylon*	*C. bengha -lensis*	*C. rotundus*	*C. difformis*	*A. bacciferia*	*E. crusgalli*	*C. dactylon*	*C. bengha -lensis*	*C. rotundus*	*C. difformis*	*A. baccife ria*
Time of Sowing												
15th June	6.84 (44.6)	6.94 (47.3)	4.39 (18.3)	4.83 (22.4)	4.61 (20.3)	4.73 (21.4)	4.66 (20.74)	5.09 (24.96)	3.45 (10.93)	4.41 (18.47)	3.97 (14.73)	3.60 (11.98)
10th July	8.01 (63.3)	8.51 (71.5)	5.15 (25.6)	6.32 (39.0)	6.13 (36.6)	5.81 (32.8)	6.37 (39.60)	6.36 (39.45)	5.36 (27.79)	5.97 (34.72)	5.59 (30.28)	5.45 (28.75)
Sem (±)	0.39	0.46	0.21	0.31	0.50	0.32	0.51	0.16	0.45	0.22	0.47	0.21
LSD (p = 0.05)	1.17	1.38	0.65	0.93	1.51	0.97	1.52	0.49	1.34	0.67	1.41	0.63
Weed management												
Azimsulfuron 60 g/ha	8.16 (65.6)	8.98 (79.8)	5.40 (28.2)	3.98 (14.93)	3.68 (12.6)	4.53 (19.6)	6.57 (42.28)	6.56 (42.12)	5.14 (25.52)	3.96 (14.75)	3.37 (10.38)	3.95 (14.63)
Cyhalofop-butyl + 2,4-D 90 g/ha + 500 g/ha	4.39 (18.3)	4.13 (16.1)	3.50 (11.3)	4.18 (16.51)	3.78 (13.3)	3.54 (11.5)	4.19 (16.56)	3.82 (13.65)	3.10 (8.65)	4.04 (15.40)	3.42 (11.72)	3.37 (10.39)
Bispyribac 30 g/ha	4.30 (17.5)	4.04 (15.4)	3.39 (10.5)	4.14 (16.24)	3.74 (13.0)	3.62 (12.1)	4.05 (15.42)	3.63 (12.24)	2.99 (7.98)	4.01 (15.13)	3.56 (11.64)	3.30 (9.93)
Anilophos + ethoxysulfuron 375 g/ha + 15 g/ha	4.53 (19.6)	4.34 (17.8)	3.58 (11.8)	4.31 (17.65)	3.97 (14.8)	3.71 (12.8)	4.22 (16.89)	3.87 (13.98)	3.24 (9.52)	4.18 (16.52)	3.59 (11.87)	3.41 (10.64)
Oxadiargyl 100 g/ha	6.74 (44.5)	6.50 (41.3)	4.50 (19.3)	5.17 (25.83)	4.61 (20.3)	4.62 (20.4)	5.67 (31.14)	4.62 (20.41)	3.95 (14.65)	5.04 (24.41)	4.07 (15.59)	4.06 (15.56)
Weedy check	8.26 (67.3)	9.04 (80.8)	5.53 (29.6)	6.54 (41.82)	6.40 (40.0)	6.43 (40.4)	6.70 (43.95)	6.58 (42.36	5.52 (29.48)	6.61 (42.74)	6.04 (35.50)	5.69 (31.45)
Weed free	1 (0.00)	1 (0.00)	1 (0.00)	1 (0.00)	1 (0.00)	1 (0.00)	1 (0.00)	1 (0.00)	1 (0.00)	1 (0.00)	1 (0.00)	1 (0.00)
Sem (±)	0.11	0.14	0.17	0.19	0.22	0.21	0.12	0.06	0.15	0.18	0.14	0.15
LSD (p = 0.05)	0.33	0.43	0.53	0.58	0.67	0.65	0.35	0.18	0.46	0.56	0.43	0.45

The figure in parenthesis are original values and transformed to √X+1.

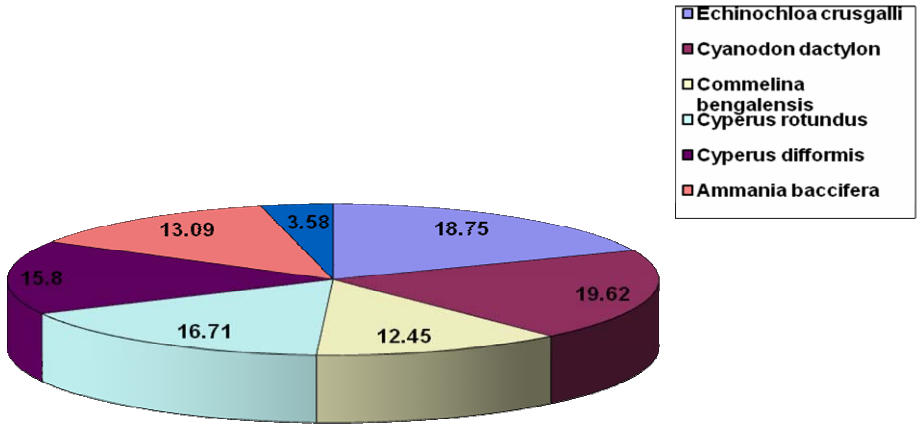

Fig. 1. Relative weed density of individual weed species in per cent of the total weed density in rice.

Table 2. Effect of sowing time and weed management practices on weed control efficiency (%) and weed index (%).

Treatments	Weed control efficiency (%)	Weed index (%)
Time of sowing		
15 June	60.54	26.59
10 July	52.43	30.97
SEm (+)	-	-
LSD (p = 0.05)	-	-
Weed management		
Azimsulfuron 60 g/ha	58.32	35.64
Cyhalofop-butyl + 2,4-D 90 g/ha + 500 g/ha	72.19	23.03
Bispyribac 30 g/ha	72.84	19.60
Anilophos + ethoxysulfuron 375 g/ha + 15 g/ha	70.13	26.09
Oxadiargyl 100 g/ha	58.08	41.06
Weedy check	0.00	56.36
Weed free	100	0.00
Sem (+)	-	-
LSD (p = 0.05)	-	-

Crop sown on 15th June and 10th July failed to show any significant impact on yield attributes and yield during the period of experimentation (Table 3). However, 15th June sown crop recorded numerically highest yield attributes and yield as compared to rice sown on 10th July. Application of bispyribac @ 30 g/ha produced significantly highest number of panicles/m^2, number of grains/panicle and 1000-grain weight which were found to be statistically at par with application of cyhalofop-butyl + 2,4-D @ 90 g/ha + 500 g/ha and anilophos + ethoxysulfuron @ 375 g/ha + 15 g/ha. The enhanced yield attributes might be due to low weed density and dry weight of weeds and high weed control efficiency which resulted in better growth of rice crop. Significantly lowest grain yield and straw yield of basmati rice was noticed in weedy check as a consequence of stiff competition imposed by weeds resulting in poor source and sink development with poor yield contributing characters and highest weed index. These results corroborated with the findings of Subhas and Jitendra (2007). Amongst the herbicidal treatments, application of bispyribac as post emergence @ 30 g/ha produced significantly highest grain and straw yields which were statistically at par with cyhalofop-butyl + 2, 4-D @ 90 g/ha + 500 g/ha and anilophos + ethoxysulfuron @ 375 g/ha + 15 g/ha. This might be due to significant reduction in weed dry matter and thereby caused reduction in crop weed competition which provided congenial environment to the crop for the better expression of vegetative and reproductive potential (Kumar *et al*. 2013).

Table 3. Effect of sowing time and weed management practices on yield attributes and yield of direct seeded basmati rice.

Treatment	No. of panicles/m^2	No. of grains/panicle	1000-grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)
Time of sowing					
15 June	146.8	77.28	22.35	2.18	3.27
10 July	145.6	76.49	21.35	2.05	3.18
Sem (±)	0.4714	0.390	0.197	0.538	0.47
LSD (p = 0.05)	NS	NS	NS	NS	NS
Weed management					
Azimsulfuron 60 g/ha	143.1	73.85	21.14	1.91	2.86
Cyhalofop-butyl + 2,4-D 90 g/ha + 500 g/ha	147.8	77.79	22.87	2.28	3.42
Bispyribac 30 g/ha	148.6	78.72	22.89	2.39	3.58
Anilophos + ethoxysulfuron 375 g/ha + 15 g/ha	147.2	77.12	22.42	2.19	3.28
Oxadiargyl 100 g/ha	143.0	73.16	20.97	1.75	2.62
Weedy check	136.8	65.93	18.03	1.29	1.93
Weed free	153.8	88.74	24.08	2.97	4.45
Sem (±)	1.113	1.003	0.396	0.130	0.116
LSD (p = 0.05)	3.34	3.01	1.19	0.39	0.35

Pooled data of two years.

While cooking amylose content and water uptake are the most important characters predicting rice cooking and eating quality feature. Amongst the weed management treatments, significantly lowest amylose content (15.89 per cent) was recorded in weed free treatment and highest amylose content was produced in weedy check treatment (Table 4). Among the herbicidal treatments, application of bispyribac @ 30 g/ha recorded significantly lowest amylose content (15.94 per cent) which was however statistically at par with application of cyhalofop-butyl + 2,4-D @ 90 g/ha + 0.5 kg/ha and anilophos + ethoxysulfuron @ 375 g/ha + 15 g/ha. While cooking significantly highest water uptake (38.94 ml) was recorded in weed free treatment and lowest was in weedy check treatment. Significantly highest water uptake (34 - 57 ml)) was recorded by the application of bispyribac @ 30 g/ha. This value was however statistically at par with application of cyhalofop-butyl + 2,4- D @ 90 g/ha + 0.5 kg/ha and anilophos + ethoxysulfuron post emergence @ 375 g/ha

+ 15 g/ha with their corresponding values of 34.09 and 34.06 ml, respectively. This might have happened due to greater number of normal kernels and more starch compaction in rice grains as compared to other herbicidal treatments. These results are in close conformity with the findings of Khaliq *et al.* (2011), Raza *et al.* (2011) and Akbar *et al.* (2012).

Table 4. Effect of sowing time and weed management practices on quality and economics of direct seeded basmati rice.

Treatment	Amylose content (%)	Water uptake while cooking (ml)	Net returns (Rs/ha)	B:C ratio
Time of Sowing				
15 June	16.02	30.60	56784	1.25
10 July	16.04	30.57	55383	1.17
Sem (±)	0.002	0.454	-	-
LSD (p = 0.05)	NS	NS	-	-
Weed management				
Azimsulfuron 60 g/ha	16.07	26.76	64458	2.64
Cyhalofop-butyl + 2,4-D 90 g/ha + 500 g/ha	15.97	33.53	80411	3.27
Bispyribac 30 g/ha	15.96	34.78	84568	3.46
Anilophos + ethoxysulfuron 375 g/ha + 15 g/ha	15.99	33.47	76397	3.24
Oxadiargyl 100 g/ha	16.05	25.45	59482	2.58
Weedy check	16.11	20.42	37635	1.70
Weed free	15.91	40.17	87528	2.10
Sem (±)	0.010	0.443	-	-
LSD (p = 0.05)	0.031	1.32	-	-

Pooled data of two years.

Among the times of sowing, 15th June sown crop recorded maximum net returns (Rs. 56784/ha) and B : C ratio (1.25) as compared to rice sown on 10th July (Table 3). Amongst weed management options, highest net returns of Rs. 84568/ha and benefit : cost ratio (3.46) was obtained with the application of bispyribac @30 g/ha which was closely followed by cyhalofop-butyl + 2, 4-D @ 90 g/ha + 500 g/ha and anilophos + ethoxysulfuron @ 375 g/ha + 15 g/ha. Similar results were also reported by Jadhav *et al.* (2013)

References

Akbar N, Iqbal A, Khan HZ, Hanif MK and Basher MU 2012. Effect of different sowing dates on the yield and yield component of direct seeded fine rice (*Oryza sativa* L.). J. Pl. Breed. Crop Sci. **2**(10): 312-315.

Biswas SK and Juilano BO 1988. Laboratory parboiling procedures and properties of parboiled rice from varieties differing in starch properties.Curr.Chem. **65**(5): 417-423.

Chalka KS and Sinha JS 2013. Problems, prospects and new approaches in weed management. Pest. Inf. **21**: 7-19.

Chauhan BS and Johnson DE 2011. Row spacing and weed control timing affect yield of aerobic rice. Field Crops Res. **121**: 226-231.

Chauhan BS, Mahajan G, Sardana V, Timsina J and Jat ML 2012. Productivity and sustainability of the rice-wheat cropping system in the Indo-Gangetic plains of the Indian subcontinent: problems, opportunities and strategies. Adv. Agron. **117**: 315-320.

Cocharan WG and Cox GM 1963. *Experimental Designs*. Asia Publishing House, Bombay, India

Jadhav AK 2013. Sowing time - a tool for weed control in direct seeded upland rice. Ind. J. Weed Sci. **45**(1): 16-18.

Juliano BO 1971. A simplified assay for milled rice amylase. Cer. Sci. Tod. **16**:334-341.

Khaliq A, Matloob A, Shafiq HM, Cheema ZA and Wahid A 2011. Evaluating sequential application of pre and post emergence herbicides in dry seeded fine rice. Pak. J. Weed Sci. Res. **17**: 111-123.

Kumar V, Singh S, Singh R, Chokar R, Malik K, Daniel CB and Ladha JK 2013. Weed management strategies to reduce herbicides in zero till rice-wheat cropping system of the Indo-Gangetic plains. Weed Tec. **27**: 241-254.

Mahajan G and Chauhan BS 2011. Effects of planting pattern and cultivar on weed and crop grown in aerobic rice system. Weed Tec. **25**: 521-525.

Mishra M and Mishra A 1997. Estimation of integrated pest management index in Jute - A new approach. Ind. J. Weed Sci. **29**(1&2): 39-42.

Raju RA 1998. *In:* Prevalent weed flora in Peninsular India, Allied pub. New Delhi, India. pp. 57.

Raza A, Saqib M, Ali S, Ijaz S, Latif M, Ahmad M, Akbar N and Ghaffar A 2011. Influence of weed management on growth, yield and quality of direct seeded rice. Weed Bio. Mgmt. **5**: 190-196.

Singh A, Singh RK, Kumar P and Sumita S 2013. Growth, weed control and yield of direct seeded rice as influenced by different herbicides. Ind. J. Weed Sci. **45**(4): 235-238.

Singh P, Singh P and Singh SS 2007. Response of aromatic rice (Pusa Basmati 1) to establishment methods, fertility levels and weed management practices. Ind. J. Weed Sci. **39**(1&2): 32-35.

Subhas C and Jitendra P. 2007. Effect of rice (*Oryza sativa*) culture, nitrogen and weed control on nitrogen competition between scented rice and weeds. Ind. J. Agron. **46**: 68.

Upasani RR, Barla S and Singh MK. 2017. Tillage and weed management in direct- seeded rice (*Oryza sativa*) and wheat *(Triticum aestivum*) cropping system. Ind. J. Agron.**62** (3):247-254.

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