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Integrated weed management in ajwain (*Trachyspermum ammi*)

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Abstract

A field experiment was conducted during *rabi* season of 2014-15, 2015-16 and 2016-17 at Seed Spice Research Station, S. D. Agricultural University, Jagudan. The treatments included of best combinations consisting of physical and chemical methods as well as alone. The studies signified the importance of hand weeding at 25 and 40 DAS or application of post emergence herbicides which could benefit the crops in reducing the different weed density and ultimately reduced the weed dry matter which resulted in increase in the crop yield. Keeping the crop weed free up to harvest recorded higher weed control efficiency (98 %) and lower weed index (0%). Higher growth and yield attributes under physical method alone and their integration with herbicide treatments might be due to effective control of weeds, significantly reduced crop–weed competition resulting in better congenial condition for growth and development of the crop. The maximum seed yield was recorded with weed free crop condition up to harvest and was at par with the treatments in which adoption of physical and chemical methods alone and their combinations. The maximum net realization was recorded with treatment T_3 *i.e* two inter-culturing followed by hand weed at 25 and 40 DAS. The highest net income per rupee investment (BCR) was recorded under treatments pre emergence application of pendimithalin @ 1.00 kg ha^{-1} + IC followed (fb) by HW at 35 DAS.

Key words : Hand weeding, interculturing, oxadiargyl, oxyfluorfen, pendimethalin,weed management.

Introduction

Ajwain *(Trachyspermum ammi)* is a native of Egypt and is cultivated in Iraq, Iran, Afghanistan, Pakistan and India. Ajwain also known as Bishop' weed, an annual herbaceous plant belonging to family Apiaceae, highly valued medicinally important seed spice. Ajwain is a profusely branched annual herb 60-120 cm tall. In India it is grown in Gujarat, Rajasthan, Madhya Pradesh and Andhra Pradesh. In arid and semi arid regions, ajwain cultivation has increased in recent past due to less requirement of costly inputs *i.e.* irrigation, fertilizer *etc* as compared to other *rabi* crops. There is wide gap between potential and actual average productivity due to lack of scientific information regarding agro techniques *viz*., sowing, fertilizer, water management and weed management *etc*. Ajwain is traditionally a *rabi* season crop and its productivity is low due to several factors, one of them being uncontrolled weed growth during the critical growth periods, and also at subsequent stages of the crop growth. Delayed germination and initial slow growth rate increases weed problem during early stage of growth, resulting in reduced yield (70–78%). The use of herbicide has transformed weed control in seed spices and reduced the cost of production. Unfortunately, majority of the farmers are quite ignorant about the proper doses of herbicides, time of application and their economics. Precise information on weed management in ajwain is essential and expected for getting healthy growth of plants. Integrated weed management approach leads to long term and effective weed control, which reduces residues load of agricultural chemicals with ultimately minimized health hazards. Manual weeding is the commonly employed practice, of late this practice has became uneconomical due to increased cost of manual labour. Besides non availability of labour during peak periods of agricultural operations and time taken for weeding makes the practice of hand weeding difficult. Keeping in view the above mentioned facts, the present study was carried out to evaluate economic feasibility of weed management practices in ajwain.

Materials and methods

The experiment was conducted during *rabi* season of 2014-15, 2015-16 and 2016-17 at Seed Spice Research Station, S. D. Agricultural University, Jagudan. The soil was loamy sand in texture, neutral in soil reaction, low in organic carbon, medium in available phosphorus and potash. The

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treatments consisted best combinations of physical and chemical methods as well as alone *viz*., T_1: Weedy check, T_2: Weed free up to harvest, T_3: Two inter-culturing followed by hand weeding at 25 & 40 DAS, T_4: Pendimethalin @ 1.0 kg ha^{-1} as pre- mergence weedicide (PE), T_5 : T_4 + Oxadiargyl @ 100 g ha^{-1} as PE at 30 DAS, T_6: T_4 + Oxyfluorfen @ 75 g ha^{-1} as PE at 30 DAS, T_7: T_4 + IC followed by HW at 35 DAS, T_8: Oxadiargyl @ 100 g ha^{-1} as pre-emergence, T_9: Oxadiargyl @ 75 as pre-emergence, T_{10}: Oxadiargyl 75 g ha^{-1} as PE + Oxyfluorfen @ 75 g ha^{-1} as PE at 30 DAS, T_{11} : T_8 + IC followed by HW at 35 DAS T_{12} : T_9 + IC followed by HW at 35 DAS. Experiment was laid out in a randomized block design and replicated thrice. Ajwain variety Gujarat Ajwain 2 was sown in the second fortnight of October during all the three years at 30 cm row to row and 10 cm, plant to plant spacing with a seed rate of 5.0 kg ha^{-1}. Irrigation was given immediately after sowing. All other standard cultural practices were followed during the cropping season. Pre and post emergence application of pendimethalin, oxadiargyl and oxyfluorfen was done with the help of a knapsack sprayer fitted with flood fan nozzle with a spray volume of 600 L ha^{-1}. In manual weed control treatments, weeds were uprooted within the row and between the row with inter-culturing as per days mentioned in each treatments. In weed free plots, the weeds were removed manually at fifteen days interval for ensuring complete weed free condition. The weed count (density) was taken from the tagged spot of 0.25 m^2 in the randomly selected each net plot and were calculated and converted into square meter basis for convenience. In order to draw a valid conclusion, the weed count data were subjected to ($\sqrt{x}$ + 0.5) as suggested by Gomez and Gomez (1984) before statistical analysis. For dry weight of weeds, the weeds were air dried completely till they attained constant weight and finally recorded for each treatment after harvest and converted in to kg ha^{-1}. Weed control efficiency and weed index were calculated by the formulae suggested by Kondap & Upadhyay (1985) and Gill & Kumar (1969). Statistical analysis procedure was followed as suggested by Panse & Sukhatme (1985).

Results and discussion

Weed Count

Significantly maximum total weed count was recorded under weedy check condition where as it was significantly lowest with treatments T_2 and T_7 at 20, 40 and 60 DAS (Table 1). Various herbicides were equally effective the controlling sedges and monocot weeds. Pendimethalin alone or in combination with oxtdiargyl or oxyfluorfen were at par but significantly superior in controlling dicot weeds as compared to the application of oxydiargyl or oxyfluorfen alone or in combination. The studies signified the importance of hand weeding at 25 and 40 DAS or application of post emergence herbicides which could benefit the crops by reducing the different weeds which ultimately reduced the weeding frequency during crop weed competition period of crop. Similar results were obtained with hand weeding in cumin by Patel *et al.,* (2016), in ajwain by Nalini *et al.,* (2017) and Meena *et al.,* (2015). Further the results are also supported by and Patel *et al.,* (2017) in fennel crop.

Dry weight of weed

Significantly the highest weed dry matter was recorded with weedy check at harvest shows in Table 2. The studies suggested the importance of hand weeding at 25 and 40 DAS or application of post emergence herbicides which could benefit the crops by reducing the weed dry matter and ultimately increasing the crop yield. Similar results were obtained with hand weeding in cumin by Patel *et al.,* (2016), in fennel by Patel *et al.,* (2017), in ajwain by Nalini *et al.,* (2017) and Meena *et al.,* (2015). The significantly minimum value of dry weight of weeds at harvest was recorded under weed free (T_2) crop condition (Table 2).

Weed control efficiency (%) and Weed index (%)

Keeping the crop weed free till harvest recorded higher weed control efficiency (98 %) and lower weed index (0%) values followed by two inter-culturing followed (fb) hand weeding at 25 & 40 (79 % and 2%) and application of pendimethalin @ 1.0 kg ha^{-1} + IC *fb* HW at 35 DAS (75 % and 4%), respectively. Maximum weed control efficiency recorded in hand weeding is due to continuous removal of weeds up to 40 days. These results are in accordance with the results indicated by Patel *et al.,* (2016) in cumin and Nalini *et al.,* (2017) in ajwain. In fennel crop Meena and Mehta (2009) observed that higher weed control efficiency at maturity was recorded with integration of herbicides with hand weedding and inter culturing.

Growth and yield attributes

Growth and yield attributes of ajwain were significantly influenced by different weed management treatments (Table 3). All growth and yield attributing characters *viz*., plant height, numbers of branches, numbers of umbels plant^{-1}, number of umbellates umbel^{-1}, number of seed and test weight were significantly maximum under weed free crop condition. Higher growth and yield attributes under physical method alone and their integration with herbicide

Table 1. Weed count (numbers / m^2) in ajwain crop at 20,40 and 60 DAS and total as influenced by different weed management practices (Mean data of three years)

Treatments	Sedges			Monocot			Dicot			Total		
	DAS			DAS			DAS			DAS		
	20	40	60	20	40	60	20	40	60	20	40	60
T_1 :Weedy check	1.38	1.61	1.69	2.14	2.29	2.39	2.63	3.32	4.07	3.96	4.96	5.34
T_2 :Weed free up to harvest	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
T_3 :Two interculturing fb hand weeding at 25 & 40	1.38	1.26	1.30	2.07	1.26	1.42	2.41	1.38	2.04	3.89	2.49	3.25
T_4 :Pendimethalin @ 1.0 kg ha^{-1} as pre- emergence	1.30	1.50	1.65	2.04	2.20	2.28	0.88	1.50	2.12	2.41	3.27	3.90
T_5 :T_4 + Oxadiargyl @ 100 g ha^{-1} as PE at 30 DAS	1.34	1.54	1.53	2.06	2.22	2.32	1.05	1.57	2.22	2.43	3.15	3.42
T_6 :T_4 + Oxyfluorfen @ 75 g ha^{-1} as PE at 30 DAS	1.30	1.45	1.53	2.08	2.29	2.37	0.88	1.83	2.27	2.43	3.32	3.89
T_7 :T_4 + IC *fb* HW at 35 DAS	1.26	0.71	1.30	2.08	0.71	1.42	0.88	0.71	1.38	2.41	0.71	1.81
T_8 :Oxadiargyl @ 100 g ha^{-1} as pre-emergence	1.38	1.53	1.61	2.09	2.22	2.29	1.23	1.80	2.41	2.48	3.74	3.94
T_9 :Oxyfluorfen @ 75 g ha^{-1} as pre-emergence	1.34	1.54	1.61	2.06	2.22	2.37	2.27	3.19	3.86	3.16	4.43	4.81
T_{10} :Oxadiargyl 75 g ha^{-1} as PE + Oxyfluorfen @75 g ha^{-1} as PE at 30 DAS	1.34	1.50	1.61	2.12	2.27	2.36	1.23	1.87	2.67	2.48	3.36	3.93
T_{11} :T_8 + IC *fb* HW at 35 DAS	1.38	0.71	1.34	2.07	0.71	1.26	1.05	0.71	1.46	2.45	0.71	2.74
T_{12} :T_9 + IC *fb* HW at 35 DAS	1.30	0.71	1.34	2.08	0.71	1.30	2.34	0.71	1.57	3.20	0.71	2.93
SEm+	0.06	0.04	0.06	0.07	0.05	0.05	0.06	0.04	0.06	0.07	0.05	0.06
CD at 5 %	0.17	0.13	0.18	0.21	0.15	0.16	0.18	0.13	0.16	0.21	0.15	0.18
CV %	14.12	11.58	14.01	11.33	10.24	9.22	14.17	8.62	8.07	8.72	6.14	5.68
Y x T	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Dry weight of weeds (Kg ha^{-1}),WCE (%) and WI (%) in ajwain crop at harvest as influenced by different weed management practices (Mean data of three years)

Treatments	Dry weight of weeds (Kg ha^{-1})				WCE	WI
	Sedges	Monocot	Dicot	Total	(%)	(%)
T_1 :Weedy check	83	200	861	1144	0	75
T_2 :Weed free up to harvest	1	2	21	24	98	0
T_3 :Two interculturing fb hand weeding at 25 & 40	22	42	181	245	79	2
T_4 :Pendimethalin @ 1.0 kg ha^{-1} as pre- emergence	53	109	187	349	70	8
T_5 :T_4 + Oxadiargyl @ 100 g ha^{-1} as PE at 30 DAS	60	117	202	379	67	11
T_6 :T_4 + Oxyfluorfen @ 75 g ha^{-1} as PE at 30 DAS	63	113	210	386	66	37
T_7 :T_4 + IC *fb* HW at 35 DAS	45	48	196	289	75	4
T_8 :Oxadiargyl @ 100 g ha^{-1} as pre-emergence	65	156	312	533	53	29
T_9 :Oxyfluorfen @ 75 g ha^{-1} as pre-emergence	73	150	554	777	32	58
T_{10} :Oxadiargyl 75 g ha^{-1} as PE + Oxyfluorfen @75 g ha^{-1} as PE at 30 DAS	65	168	338	571	50	29
T_{11} :T_8 + IC *fb* HW at 35 DAS	25	44	329	398	65	13
T_{12} :T_9 + IC *fb* HW at 35 DAS	26	44	334	404	65	44
SEm+	2.3	2.2	15	15	--	--
CD at 5 %	7	6	45	45	--	--
CV %	14.62	6.64	14.38	9.91	--	--
Y x T	NS	NS	NS	NS	--	--

Table 3. Growth, yield and quality attributes of ajwain as influenced by different weed management treatments (Pooled data)

Treatments	Plant height (cm)	No. of branches plant^{-1}	No. of umbels plant^{-1}	No. of umballates umbel^{-1}	No. of seeds umballate^{-1}	Test weight (g)	Volatile oil (%)
T_1 :Weedy check	78.4	4.6	25.4	8.8	13.7	0.83	3.4
T_2 :Weed free up to harvest	112.4	10.2	38.0	13.6	17.7	0.96	3.6
T_3 :Two interculturing fb hand weeding at 25 & 40	110.6	10.1	37.7	13.5	17.5	0.95	3.6
T_4 :Pendimethalin @ 1.0 kg ha^{-1} as pre- emergence	109.8	10.0	37.4	13.0	17.3	0.95	3.6
T_5 :T_4 + Oxadiargyl @ 100 g ha^{-1} as PE at 30 DAS	110.0	9.8	36.9	12.5	16.9	0.94	3.5
T_6 :T_4 + Oxyfluorfen @ 75 g ha^{-1} as PE at 30 DAS	106.6	9.0	36.5	12.1	16.4	0.94	3.5
T_7 :T_4 + IC *fb* HW at 35 DAS	112.1	9.7	37.5	13.3	17.0	0.93	3.5
T_8 :Oxadiargyl @ 100 g ha^{-1} as pre-emergence	104.6	9.0	35.6	12.4	16.8	0.94	3.5
T_9 :Oxyfluorfen @ 75 g ha^{-1} as pre-emergence	88.8	6.6	29.1	10.5	14.5	0.85	3.5
T_{10} :Oxadiargyl 75 g ha^{-1} as PE + Oxyfluorfen @75 g ha^{-1} as PE at 30 DAS	105.7	8.4	35.8	11.6	16.5	0.94	3.5
T_{11} :T_8 + IC *fb* HW at 35 DAS	109.9	9.7	35.9	12.4	16.6	0.93	3.5
T_{12} :T_9 + IC *fb* HW at 35 DAS	97.7	7.2	35.8	10.8	14.5	0.93	3.5
S. Em. ±	2.6	0.2	0.8	0.5	0.5	0.01	0.05
C.D. at 5 %	7.4	0.5	2.4	1.4	1.3	0.04	NS
C.V. %	7.56	6.67	7.55	12.41	8.45	4.93	4.92
Y x T	NS	NS	NS	NS	NS	NS	NS

treatments might be due to effective control of weeds, significantly reduced crop–weed competition ultimately resulting in better congenial condition for growth and development of the crop. However these values were minimum under weedy check condition. These findings are also in conformity with those reported by Patel *et al.,* (2016) in cumin and Nalini *et al.,* (2017) in ajwain crop. Volatile oil content of seed was not influenced significantly by different treatments.

Seed yield

Seed yield of ajwain was significantly influenced by different weed management treatments during the course of investigation and in pooled data also (Table 4). The maximum seed yield was recorded with weed free crop condition up to harvest and was at par with the treatments in which use of physical and chemical methods and their combinations were adopted *viz*., T_3, T_4, T_5, T_7 and T_{11} but significantly superior over rest of the treatments. However, significantly minimum seed yield was recorded when weed management practices were not adopted *i.e.* weedy check (T_1). Alone pre emerge application of oxyfluorfen @75 g ha^{-1} or oxadiargyl @ 100 g ha^{-1} or post emergence application of these two herbicides were not found to be effective to control the weeds in ajwain. Meena and Mehta (2009) reported that hand weeding and application of pre emergence weedicides reduced the dry matter of weeds and thus increased seed yield of seed spices. Mathukia *et al.,* (2015) reported that weed free treatment secured higher cumin seed yield. Kumar (2001) also reported similar results. In addition to this the least weed population and dry weight were recorded under integrated treatments which was also responsible for better seed yield. Yadav *et al.,* (2005) reported that pendimethalin at 1.0 kg ha^{-1} (pre-emergence) also controlled the weeds more effectively (79.3%) and resulted in 242.9 per cent higher seed yield than the control. The results are in accordance with those of Patel *et al.,* (2016) in cumin, Patel *et al.,* (2017) in fennel, Nalini *et al.,* (2017) and Meena *et al.,* (2015) in ajwain.

Economics

The maximum seed yield, gross realization and cost of cultivation were recorded under treatment T_2 : weed free crop condition up to harvest (Table 5), whereas, the maximum net realization was recorded with treatment T_3 *i.e* two interculturing followed by hand weeding at 25 and 40 DAS. The highest net income per rupee investment (BCR) was recorded under treatments pre emergence application of pendemithalin @ 1.00 kg ha^{-1} + IC *fb* HW at 35 DAS (T_4) and two inter-culturing followed by hand weeding at 25 and 40 DAS. The higher seed yield under these treatments as a result of better weed control is responsible for higher net realization per hectare. Similar trend was also observed by Yadav *et al*., (2012) and Patel *et al.,* (2016).

Table 4. Seed yield of ajwain as influenced by different weed management treatments

Treatments	Ajwain seed yield (kg ha^{-1})			
	2014-15	2015-16	2016-17	Pooled
T_1 :Weedy check	167	218	213	202
T_2 :Weed free up to harvest	815	790	817	810
T_3 :Two interculturing fb hand weeding at 25 & 40	787	772	806	793
T_4 :Pendimethalin @ 1.0 kg ha^{-1} as pre- emergence	722	758	748	743
T_5 :T_4 + Oxadiargyl @ 100 g ha^{-1} as PE at 30 DAS	713	720	742	725
T_6 :T_4 + Oxyfluorfen @ 75 g ha^{-1} as PE at 30 DAS	440	539	553	511
T_7 :T_4 + IC *fb* HW at 35 DAS	782	774	777	778
T_8 :Oxadiargyl @ 100 g ha^{-1} as pre-emergence	484	633	613	577
T_9 :Oxyfluorfen @ 75 g ha^{-1} as pre-emergence	324	304	392	340
T_{10} :Oxadiargyl 75 g ha^{-1} as PE + Oxyfluorfen @75 g ha^{-1} as PE at 30 DAS	472	630	635	579
T_{11} :T_8 + IC *fb* HW at 35 DAS	691	687	742	706
T_{12} :T_9 + IC *fb* HW at 35 DAS	398	474	483	452
S. Em. ±	45	43	44	25
C.D. at 5 %	131	125	128	71
C.V. %	13.69	12.13	12.09	12.61
Y x T	--	--	--	NS

Table 5. Economics of the different treatments as influenced by different weed management treatments

Treatments	Seed yield (kg ha^{-1})	Gross realization (` ha^{-1})	Gross expenditure (` ha^{-1})	Net return (` ha^{-1})	BCR
T_1 :Weedy check	202	24199	22759	1441	0.06
T_2 :Weed free up to harvest	810	97193	31422	65771	2.09
T_3 :Two interculturing fb hand weeding at 25 & 40	793	95148	27957	67191	2.40
T_4 :Pendimethalin @ 1.0 kg ha^{-1} as pre- emergence	743	89156	24821	64335	2.59
T_5 :T_4 + Oxadiargyl @ 100 g ha^{-1} as PE at 30 DAS	725	86999	28151	58849	2.09
T_6 :T_4 + Oxyfluorfen @ 75 g ha^{-1} as PE at 30 DAS	511	61299	25610	35689	1.39
T_7 :T_4 + IC *fb* HW at 35 DAS	778	93318	27420	65899	2.40
T_8 :Oxadiargyl @ 100 g ha^{-1} as pre-emergence	577	69201	26089	43112	1.65
T_9 :Oxyfluorfen @ 75 g ha^{-1} as pre-emergence	340	40776	23548	17228	0.73
T_{10} :Oxadiargyl 75 g ha^{-1} as PE + Oxyfluorfen @ 75 g ha^{-1} as PE at 30 DAS	579	69489	27225	42264	1.55
T_{11} :T_8 + IC *fb* HW at 35 DAS	706	84764	28689	56075	1.95
T_{12} :T_9 + IC *fb* HW at 35 DAS	452	54206	26149	28057	1.07

Price :Ajwain seed ₹ 120 kg^{-1}, Oxadiargyl : ₹ 1550 lit.$^{-1}$, Pendimethalin : ₹ 450 lit.$^{-1}$, Oxyfluorfen : ₹ 900 lit.$^{-1}$

Conclusions

Based on the data obtained in the present study it can be inferred that for effective control of weeds and to get the maximum seed yield, adopt two inter-culturing followed by two hand weeding at 25 and 40 DAS and combine practice of herbicides with physical weed control can be adopted. Similarly during scarcity of labour to achieve the highest net income per rupee investment (BCR) pre emergence application of pendimithalin @ 1.00 kg ha^{-1} + IC *fb* HW at 35 DAS can also be adopted.

References

Gill, G. S. and Kumar, V. 1969. Weed index: a new method for reporting weeds control traits. *Indian J. Agron.* 16: 96–98.

Gomez, K. A. and Gomez, A. A. 1984. Statistical procedure for agricultural research (IInd Edition). John Willey & Sons Publication : pp : 304-305.

Kondap, S. M. and Upadhaya, U. C. 1985. A practical manual on weed control, Oxford and IBHPub. Co., New Delhi, p.55.

Kumar, S. 2001. Critical period of weed competition in cumin (*Cuminum cyminum* L.). *Ind.J. Weed Sci.*33 : 30-33.

Mathukia, R. K., Sagarka, B. K., Panaraand, D. M. and Jadav, C. N. 2015. Integrated weed management in cumin (*Cuminum cyminum* L.). Paper presented and published in 25th Asian-Pacific Weed Science Society Conference on "Weed Science for Sustainable Agriculture, Environment and Biodiversity", Hyderabad, India during 13-16 October, 2015.

Meena, S. S. and Mehta, R. S. 2009. Economic feasibility of weed management practices in cumin (*Cuminum cyminum* L.). *Indian J. Hort.* 67:189–192.

Meena, R. L., Meena, S. S., Mehta, R.S. and Meena, R. D. 2015. Weed management in ajwain (*Trachyspermum ammi* L.) *J. Spices and Aromatic Crops* 24 (2) : 124-128 .

Nalini, N. Srinivas, A., Ramprakash, T. and Praveen, Rao V. 2017. Weed Management in Ajwain (*Trachyspermum ammi*) *Int. J. Pure App. Biosci.* 5 (4): 932-939.

Panse, V. G. and Sukhatme, P. V. 1985. Statistical Method for Agricultural workers, I.C.A.R., New Delhi.

Patel, S. M., Amin, A. U. and Patel, J. A. 2016. Effect of weed management practices on weed indices, yield and economics of cumin (*Cuminum cyminum* L.). *Int. J. Seed Spices* 6(2), :78-83.

Patel, S. M., Amin, A. U., Patel, S. P. and Patel, J. A. 2017. Influence of weed management practices on weeds, yield, quality and economics of fennel. *Int. J. Seed Spices* 7(2) :45-49.

Yadav, S. S., Sharma, O. P., Yadav, R. D. 2005. Comparative efficacy of herbicidal and manual weed control in cumin (*Cuminutn cyminum*) at different levels of nitrogen. *Indian J. Agronomy*, 50(1) :77-79.

Yadav, Anupriya, Patel, J. C., Mehta, R. S. and Meena Taramani 2012. Growth, yields and economics of cumin (*Cuminum cyminum* L.) production as affected by weed management practices. *Int. J. Seed Spices* 2 (2) :27-29.

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