Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2021; Sp 10(1): 434-437
Received: 10-11-2020
Accepted: 21-12-2020

Ankit
Ph.D., Scholar, Department of Agronomy College of Agriculture CSKHPKV, Palampur, Himachal Pradesh, India

AD Bindra
Principal Scientist, Department of Agronomy, CSKHPKV, Rice and Wheat Research Centre, Malan, Kangra, Himachal Pradesh, India

SS Rana
Principal Scientist, Department of Agronomy, College of Agriculture CSKHPKV, Palampur, Himachal Pradesh, India

Sandeep Manuja
Department of Agronomy, College of Agriculture CSKHPKV, Palampur, Himachal Pradesh, India

Corresponding Author:
Ankit
Ph.D., Scholar, Department of Agronomy College of Agriculture CSKHPKV, Palampur, Himachal Pradesh, India

Productivity and profitability of turmeric as influenced by integrated weed management

Ankit, AD Bindra, SS Rana and Sandeep Manuja

Abstract
Twelve weed control treatments *viz.* metribuzin at 0.70 kg/ha followed by (fb) hand weeding at 45 and 75 days after planting (DAP), metribuzin at 0.70 kg/ha fb straw mulch at 10 t/ha fb hand weeding at 75 DAP, pendimethalin at 1 kg/ha fb hand weeding at 45 and 75 DAP, pendimethalin at 1 kg/ha fb straw mulch at 10 t/ha fb hand weeding at 75 DAP, atrazine at 0.75 kg/ha fb hand weeding at 45 and 75 DAP, atrazine at 0.75 kg/ha fb straw mulch at 10 t/ha fb hand weeding at 75 days, oxyfluorfen at 0.30 kg/ha fb hand weeding at 45 and 75 DAP, glyphosate at 1.23 kg/ha fb hand weeding at 45 and 75 DAP, glyphosate at 1.85 kg/ha fb hand weeding at 45 and 75 DAP, hand weeding at 25, 45 and 75 DAP, weed control with organic practice (mulch) and unweeded check were evaluated for weed control in turmeric on silty clay loam soil at Palampur during 2017. Total weed count increased with the age of the crop with highest values recorded at 120 DAP after which the total weed count declined. Contrary to this maximum dry weight of weeds was recorded at 150 DAP which declined at later stage. All the weed control treatments significantly reduced the total weed count and dry weight of weeds as compared to the weedy check. Amongst different herbicide treatments application of metribuzin @ 0.70 kg/ha fb straw mulch fb hand weeding resulted in significantly lowest weed count at all stages of observation as well as at harvest though this treatment was at par with metribuzin @ 0.70 kg/ha fb two hand Weedings. These two treatments along with application of atrazine @ 0.75 kg/ha fb two hand weedings and atrazine @ 0.75 kg/ha fb straw mulch fb one hand weeding resulted in significantly lower dry matter accumulation by weeds as compared to other herbicide treatments. Highest fresh and cured rhizome yield was recorded with the use of metribuzin fb straw mulch fb hand weeding at 75 DAP though this treatment was at par hand weeding and all other herbicide treatments except the treatment in which oxyfluorfen was used. The present study indicates the need of including mulch in any effective weed management strategy for turmeric.

Keywords: Turmeric, weeds, herbicides, yield, economics

Introduction
Turmeric (*Curcuma longa* L.) is one of the ancient and most sacred spices of India and is also known as "Indian Saffron", "golden spice" or "spice of life" (Patel *et al*. 2012) [12]. It has been used as spice, cosmetic and medicine for long time in the countries of South Asia, particularly in India, Bangladesh and Sri Lanka. It is used as blood purifier, antiseptic and also helps in curing problems like indigestion, throat infection and common cold. In addition this wonder herb has anti - cancer and anti - viral properties besides being used for dressing of wounds. It is also useful in treating dropsy, wounds and inflammations (Khanna 1999) [8].

India is largest turmeric producer, consumer and exporter of this crop where it is cultivated on an area of 253.35 thousand hectare with total production of 976.97 thousand tonnes (Anonymous 2019) [1]. It is also one of the most important spice crops of low and mid hills of Himachal Pradesh where it is cultivated on an area of about 274 hectare with the total production of 170 tonnes (Anonymous[2] 2019) [2], mostly in areas where maize crop cannot be grown because of the attack by monkeys, wild boars, stray animals and porcupines. Turmeric is a long duration crop with a slow initial growth. This crop takes a long time to emerge and develop a canopy structure sufficient to compete with weeds and hence is prone to weed infestation. It has been observed that weed infestation can reduce the yield of this crop to the extent of 35 – 40% (Krishnamurthy and Ayyaswamy 2000, Kaur *et al*. 2008) [9, 7].

Non availability of labour hinders the timely removal of weeds from turmeric fields which makes chemical weed management a viable option for the farmers. Very little work has been done to study the effectiveness of different herbicides separately as well as with mulch and hand weeding, particularly for the typical agro-eco-situations of Himachal Pradesh. Keeping these points in view a study was initiated to develop an effective weed management strategy in turmeric for mid hills oh Himachal Pradesh.

Materials and Methods

The field experiment was carried out at Research Farm of Department of Agronomy of CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur. The experimental site was located at $32^0 6'$ N latitude and $76\ ^0 3'$ E longitude and at an altitude of 1290.8 m above mean sea level. The site falls in sub-humid subtropical mid-hills zone of Himachal Pradesh. The area receives annual rainfall of about 2500 mm per annum, major portion of which (about 80%) is received during monsoon months of June to September. Soil of the experimental site was acidic in reaction and silty-clay loam in texture. On the basis of chemical analysis, the soil was categorized as low in available nitrogen, high in available phosphorus and medium in available potassium. The field experiment was laid out in randomised block design with 12 weed control treatments *viz*. metribuzin at 0.70 kg/ha followed by (fb) hand weeding at 45 and 75 days after planting (DAP), metribuzin at 0.70 kg/ha fb straw mulch at 10 t/ha fb hand weeding at 75 DAP, pendimethalin at 1 kg/ha fb hand weeding at 45 and 75 DAP, pendimethalin at 1 kg/ha fb straw mulch at 10 t/ha fb hand weeding at 75 DAP, atrazine at 0.75 kg/ha fb hand weeding at 45 and 75 DAP, atrazine at 0.75 kg/ha fb straw mulch at 10 t/ha fb hand weeding at 75 days, oxyfluorfen at 0.30 kg/ha fb hand weeding at 45 and 75 DAP, glyphosate at 1.23 kg/ha fb hand weeding at 45 and 75 days, glyphosate at 1.85 kg/ha fb hand weeding at 45 and 75 DAP, hand weeding at 25, 45 and 75 DAP, weed control with organic practice (mulch) and unweeded check. The rhizomes of turmeric variety *Palam Pitamber* were planted in rows 45 cm apart using seed rate of 20q/ha. Rows were opened with the help of hand plough and after putting rhizomes in the rows at 25 cm distance were covered with the soil properly. The crop was fertilized with 30 kg N, 30 kg P_2O_5, and 60 kg K_2O per hectare. The herbicides and interculture operations were carried out as per the treatments. Mulching was done with rice straw after the herbicides were sprayed on second day as per treatment. Care was taken to ensure uniform thickness of the mulch and coverage of whole area of the plot. On maturity, the crop from net plots was harvested when the leaves turned yellow or dry. The rhizomes were dug taking care that they were not cut or damaged. The rhizomes were then cleaned to remove soil and weighed for fresh weight. The weed count was recorded at 90, 120, 150 DAP and at harvest by randomly throwing a quadrat in the plot and counting the weeds of different species which were than dried to get total dry matter accumulation by weeds. The rhizomes from net plot were dug up, cleaned and weighed. The produce was recorded in kilograms and was converted to t/ha. The rhizomes were then subjected to curing and cured rhizome yield was also recorded. In order to work out the most profitable treatment, the economics of each treatment was worked out on the basis of prevalent market prices of the inputs and outputs. Cost of cultivation was calculated by adding all the costs involved in each operational input. The yield of the crop was converted into gross return in rupees based on prevailing market price. The treatment wise net return was obtained by subtracting the cost of cultivation from gross return. Net return per rupee invested was obtained by dividing net return with cost of cultivation while net return over weedy check were obtained by subtracting the net return of weedy check from net return of the treatment. The MBCR was obtained by dividing net returns over weedy with variable cost as follow:

$$\text{Marginal benefit cost ratio} = \frac{\text{Net returns over weedy (INR/ha)}}{\text{Variable cost}}$$

The data obtained were subjected to statistical analysis as per Gomez and Gomez (1984) [5] and were tested at 5 per cent level of significance to interpret the treatment differences.

Results and Discussion

Alternanthera philoxeroides, *Cynodon dactylon* and *Echinochloa colona* were the major weeds of the experimental field constituting 16.2, 14.0 and 11.6 per cent of total weed population, respectively. In addition *Commelina benghalensis, Cyperus iria, Digitaria sanguinalis, Ageratum conyzoides and Pennisetum clandestinum* were the other major weeds which constituted 10.5, 7.0, 9.2, 10.5 and 9.2 per cent of total weed population, respectively. Almost similar type of weed flora in turmeric has also been reported by Kumar *et al*. (2013) [10] under Palampur conditions. The count of *Echinochloa colona, Alternanthera philoxeroides, Commelina benghalensis, Digitaria sanguinalis and Ageratum conyzoides* was highest at 120 DAP and thereafter it gradually decreased.

All the weed control treatments resulted in significant reduction in total weed count as compared to weedy check at all the stages of observation (Table 1). Significantly lower total weed count at 90 DAP was recorded with the application of metribuzin fb straw mulch fb hand weeding though this treatment was at par with hand weeding, application of mulch as well as all other herbicide treatments except treatments in which pendimethalin was used along with hand weeding and / or mulch application while significantly highest total weed count was recorded in the weedy check. Similar trend was also recorded at 150 DAP with weedy check recording significantly highest total weed count while all the other treatments remaining at par with each other though performance of metribuzin was comparatively better than other herbicides used in this trial. However the total weed count observed at 180 DAP showed a slightly different trend with the lowest count recorded with the use of metribuzin fb straw mulch fb hand weeding though this treatment was at par with hand weeding as well as all the other herbicide treatments except the treatments in which atrazine was used. The results so obtained indicate the effectiveness of using straw mulch in reducing weed population in turmeric.

The data on the effect of different herbicides on the total dry matter accumulation by weeds at periodic intervals (90, 150 and 180 DAP) has been given in Table 2. Significantly highest dry matter accumulation by weeds at all the stages of observation was recorded in the weedy check treatment. At 90 DAP significantly lowest total weed dry matter accumulation was recorded with the application of metribuzin fb straw mulch fb one hand weeding though this treatment was at par with the application of metribuzin fb two hand weedings as well as with application of atrazine fb straw mulch fb one hand weeding and atrazine fb two hand weedings. Similar trend was also observed at 150 DAP as well as 180 DAP where use of metribuzin with or without straw mulch recording significantly lower dry matter accumulation by weeds. Application of pendimethalin and oxyfluorfen with or without straw mulch were not that effective in controlling weeds that emerge during the later part of crop growth. Similarly both the doses of glyphosate were also not effective in managing weeds in turmeric.

The weed control treatments also brought about significant variation in rhizome yield (Table 3) of turmeric. Significantly highest fresh rhizome yield was recorded with the application of metribuzin fb straw mulch fb one hand weeding though this treatment was at par with all other treatments except weedy check and application of oxyfluorfen fb two hand weedings. Similar trend was also observed for the cured rhizome yield. Weeds in weedy check reduced turmeric fresh and cured rhizome yield by about 53 per cent. Mulching appeared to be an important practice in turmeric as the organic weed control treatment in which only mulch was used was as effective as other herbicidal treatments in increasing fresh and cured rhizome yield. These results so obtained also indicated that weed control in turmeric is an essential requirement for obtaining higher productivity of this crop. Also integrating the

use of herbicides with the use of mulch as well as one or two manual weedings also helped achieving higher yield. The superiority of weed control in turmeric has been reported by several workers all over the world (Gill *et al*. 2000 [4]; Singh *et al*. 2002 [14]; Ishimine *et al*. 2003 [6]; Kaur *et al*. 2008 [7]; Ratnam *et al*. 2012 [13]; Kumar *et al*. 2014 [11]; Bharty *et al*. 2016 [3].

Data on the effect of different weed control treatments on the economics of turmeric production has been given in Table 4 which revealed that the weedy check gave the gross return which was lower than the cost of production of that treatment resulting in net loss in weedy check treatment. Highest gross return was recorded with the application of metribuzin fb straw mulch fb one hand weeding though it was almost similar to that obtained with the application of metribuzin fb two hand weedings as well as with the treatments in which atrazine was used along with hand weedings and / or straw mulch. The other herbicides tested *viz*., pendimethalin and glyphosate also gave higher gross return though oxyfluorfen was not effective in controlling weeds and gave lowest gross return among all the weed control treatments. Similar trend was observed with respect to net return as well as net return per rupee invested with oxyfluorfen application fb two hand weedings giving lowest net return as well as net return per rupee invested among weed control treatments while treatments in which metribuzin or atrazine were used giving higher net return and net return per rupee invested. The net return per rupee invested was comparatively lower than the value achieved in other crops which was due to very high cost of planting material of turmeric. Net return over weedy check as well as marginal benefit cost ratio (MBCR) also followed similar trend with treatments in which metribuzin or atrazine were used showing higher values of these economic indices while treatment having oxyfluorfen recorded lowest values. Treatment in which weeds were manually removed thrice also gave lower values indicating the necessity of integrating herbicides, mulch and hand weeding for effectively managing weeds in this important spice crop.

Based on our findings, it could be concluded that weeds cause significant losses in the yield of turmeric and needs to be managed with integrated use of herbicides, mulch and manual weeding. Satisfactory yield and profit can be obtained by use of either metribuzin (0.70 kg/ha) or atrazine (0.75 kg/ha) fb straw mulch (10 t/ha) fb one hand weeding at 75 DAP.

Table 1: Effect of weed control treatments on total weed count (No./m^2) at different stages of observations

	Treatments	Total weed count (No./m^2)		
		90 DAP	150 DAP	180 DAP
T_1	Metribuzin fb hand weeding twice	12.0 (144.0)	14.0 (196.3)	10.8 (117.9)
T_2	Metribuzin fb straw mulch fb hand weeding	11.0 (120.0)	13.3 (179.2)	10.7 (117.3)
T_3	Pendimethalin fb hand weeding twice	14.0 (197.3)	14.6 (212.3)	12.5 (157.9)
T_4	Pendimethalin fb straw mulch fb hand weeding	14.5 (213.3)	14.6 (212.3)	12.7 (163.2)
T_5	Atrazine fb hand weeding twice	11.8 (138.7)	14.7 (216.5)	13.9 (198.9)
T_6	Atrazine fb straw mulch fb hand weeding	12.0 (144.0)	15.3 (234.7)	14.4 (208.0)
T_7	Oxyfluorfen fb hand weeding twice	13.2 (176.0)	14.6 (214.9)	12.0 (144.0)
T_8	Glyphosate 1.23 kg / hafb hand weeding twice	13.0 (170.7)	14.5 (211.2)	11.5 (132.3)
T_9	Glyphosate 1.85 kg / hafb hand weeding twice	13.7 (189.3)	14.6 (220.8)	13.0 (169.6)
T_{10}	Hand weeding thrice	13.8 (192.0)	14.3 (205.9)	10.9 (119.5)
T_{11}	Weed management with organic practice (Mulch)	13.5 (186.7)	15.7 (250.7)	14.0 (197.3)
T_{12}	Weedy check	17.2 (294.4)	20.5 (421.3)	18.6 (346.7)
	S.Em±	1.0	0.9	0.9
	LSD (P=0.05)	2.9	2.7	2.6

Data transformed to square root transformation ($\sqrt{x+0.5}$), values given in parenthesis are the means of original value, DAP=Days after planting, fb=followed by

Table 2: Effect of weed control treatments on total dry matter accumulation by weeds at different stages of observations

	Treatments	Dry matter accumulation (g/m^2)		
		90 DAP	150 DAP	180 DAP
T_1	Metribuzin fb hand weeding twice	7.1 (50.7)	12.7 (161.1)	11.5 (132.8)
T_2	Metribuzin fb straw mulch fb hand weeding	6.8 (45.3)	11.6 (133.3)	11.2 (124.3)
T_3	Pendimethalin fb hand weeding twice	10.9 (119.0)	17.4 (304.0)	16.7 (277.3)
T_4	Pendimethalin fb straw mulch fb hand weeding	10.8 (115.6)	17.1 (293.3)	16.5 (272.0)
T_5	Atrazine fb hand weeding twice	7.5 (56.0)	14.6 (213.3)	12.7 (160.0)
T_6	Atrazine fb straw mulch fb hand weeding	7.7 (58.7)	14.8 (218.7)	12.4 (154.7)
T_7	Oxyfluorfen fb hand weeding twice	9.6 (91.8)	17.4 (304.0)	16.5 (272.0)
T_8	Glyphosate 1.23 kg / ha fb hand weeding twice	9.5 (90.7)	15.5 (245.3)	14.9 (224.0)
T_9	Glyphosate 1.85 kg / ha fb hand weeding twice	8.5 (74.1)	17.3 (298.7)	16.5 (272.0)
T_{10}	Hand weeding thrice	10.4 (108.8)	17.4 (304.0)	16.6 (277.3)
T_{11}	Weed management with organic practice (Mulch)	10.3 (106.7)	17.0 (288.0)	15.8 (250.7)
T_{12}	Weedy check	17.9 (320.0)	24.2 (586.7)	20.0 (400.0)
	S.Em±	0.4	0.5	0.5
	LSD (P=0.05)	1.2	1.6	1.4

Data transformed to square root transformation ($\sqrt{x+0.5}$), values given in parenthesis are the means of original value, DAP=Days after planting, fb=followed by

Table 3: Effect of treatments on fresh and cured rhizome yield (t/ha) of turmeric

	Treatments	Fresh rhizome yield (t/ha)	Cured rhizome yield (t/ha)
T_1	Metribuzin fb hand weeding twice	8.92	5.48
T_2	Metribuzin fb straw mulch fb hand weeding	9.02	5.55
T_3	Pendimethalin fb hand weeding twice	7.55	4.64
T_4	Pendimethalin fb straw mulch fb hand weeding	7.18	4.42
T_5	Atrazine fb hand weeding twice	8.69	5.35
T_6	Atrazine fb straw mulch fb hand weeding	8.62	5.30
T_7	Oxyfluorfen fb hand weeding twice	6.29	3.87
T_8	Glyphosate 1.23 kg / ha fb hand weeding twice	7.96	4.90
T_9	Glyphosate 1.85 kg / ha fb hand weeding twice	7.54	4.64
T_{10}	Hand weeding thrice	7.78	4.78
T_{11}	Weed management with organic practice (Mulch)	7.78	4.78
T_{12}	Weedy check	4.26	2.62
	S.Em±	0.70	0.43
	LSD (P=0.05)	2.06	1.27

Table 4: Effect of weed control treatments on economics of turmeric production

	Treatments	**Gross return (INR/ha)**	**Net return (INR/ha)**	**Net return per rupee invested (INR/ha)**	**Net return over weedy check (INR/ha)**	**MBCR**
T_1	Metribuzin fb hand weeding twice	222917	91946	0.70	96305	5.26
T_2	Metribuzin fb straw mulch fb hand weeding	225463	95318	0.73	99676	5.68
T_3	Pendimethalin fb hand weeding twice	188657	57439	0.44	61798	3.34
T_4	Pendimethalin fb straw mulch fb hand weeding	179537	47383	0.36	51742	2.67
T_5	Atrazine fb hand weeding twice	217361	87887	0.68	92246	5.45
T_6	Atrazine fb straw mulch fb hand weeding	215509	85540	0.66	89899	5.17
T_7	Oxyfluorfen fb hand weeding twice	157176	25463	0.19	29822	1.57
T_8	Glyphosate 1.23 kg / ha fb hand weeding twice	199074	70005	0.54	74364	4.49
T_9	Glyphosate 1.85 kg / ha fb hand weeding twice	188426	59373	0.46	63732	3.85
T_{10}	Hand weeding thrice	194444	53904	0.38	58263	2.16
T_{11}	Weed management with organic practice (Mulch)	194444	56874	0.41	61233	2.52
T_{12}	Weedy check	106481	-4359	-0.04	0	

References

1. Anonymous. Directorate of Arecanut and spices development, Ministry of Agriculture and Family Welfare, Government of India 2019.
2. Anonymous. Ministry of Agriculture and Family Welfare, Government of India 2019. https://www.aps.dac.gov.in/apy/Public_Report1.aspx
3. Bharty S, Barla S, Upasani RR, Faruque R. Integrated weed management in turmeric (*Curcuma longa* L.). Indian Journal of Ecology 2016;43: 522-525.
4. Gill BS, Randhawa GS, Saini SS. Integrated weed management in turmeric (*Curcuma longa* L.). Indian Journal of Weed Science 2000;32:114-115.
5. Gomez KA, Gomez AA. Statistical Procedure for Agricultural Research. Edn 2, Wiley Inter Science, New York, USA 1984, 680
6. Ishimine Y, Hossain MA, Ishimine Y, Murayama S. Optimal planting depth for turmeric (*Curcuma longa* L.) cultivation in dark red soil in Okinawa Island, Southern Japan. Plant Production Science 2003;6(1):83-89
7. Kaur K, Bhullar MS, Kaur J, Walia US. Weed management in turmeric (*Curcuma longa* L.) through integrated approaches. Indian Journal of Agronomy 2008;53(3):229-234.
8. Khanna NM. Turmeric-Nature's precious gift. Current Science 1999;76:135-13
9. Krishnamurthy VV, Ayyaswamy M. Effect of herbicides on yield of turmeric. Spice India 2000;13:9-11
10. Kumar S, Rana SS, Angirus NN. Weed management in black gram with specific reference to *Ageratum conyzoides*. Himachal journal of Research. 2013;39(2):111-119
11. Kumar S, Rana SS, Sharma N. Weed management in turmeric. In Biennial conference of Indian Society of Weed Science on "Emerging challenges in weed management". 15-17 February. Directorate of Weed Science Research, Jabalpur, Madhya Pradesh, India 2014, pp.153.
12. Patel GS, Verma LR, Verma Pand, Patel AG. Effect of integrated nutrient management on yield of turmeric (*Curcuma longa* L.) c.v. Kesar under North Gujrat condition. The Asian Journal of Horticulture 2012;7(1):5-8
13. Ratnam M, Rao AS, Reddy TY. Integrated weed management in turmeric (*Curcuma longa* L.). Indian Journal of Agronomy 2012;57:82-84
14. Singh A, Singh B, Vaishya RD. Integrated weed management in turmeric (*Curcuma longa* L.) planted under poplar plantation. Indian Journal of Weed Science 2002;34(3-4): 329-330