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# Growth and yield of turmeric (*Curcuma longa* L.) under different weed management

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**ABSTRACT**

*A field experiment was conducted at Birsa Agricultural University, Ranchi during kharif season of 2012 and 2013 to study the efficacy of different weed control methods on weed dynamics and productivity of turmeric. The treatments comprised of integrated application of herbicides along with hoeing and straw mulch including weed free and weedy control. The results of pooled data revealed that application of metribuzin 0.7 kg ha$^{-1}$ fb. by two hoeing being similar to weed free recorded reduced grassy and sedges weed at 30 DAP whereas, application of pendimethalin 1.0 kg ha$^{-1}$ fb. two hoeing and application of pendimethalin 1.0 kg ha$^{-1}$ fb. straw mulch 10 t ha$^{-1}$ fb. one hand weeding were similar with weed free at 60 DAP. Application of pendimethalin 1.0 kg ha$^{-1}$ fb. two hoeing similar to weed free recorded reduced total weed density and weed dry matter accumulation at 30 and 60 DAS. Application of metribuzin 0.7 kg ha$^{-1}$ fb. by two hoeing recorded maximum yield (24.66 t ha$^{-1}$) consequently higher gross return (616519 RS. ha$^{-1}$) similar to metribuzin 0.7 kg ha$^{-1}$ fb. straw mulch 10 t ha$^{-1}$ fb. one HW, pendimethalin 1.0 kg ha$^{-1}$ fb. two hoeing, pendimethalin 1.0 kg ha$^{-1}$ fb. straw mulch 10 t ha$^{-1}$ fb. one HW, atrazine 0.75 kg ha$^{-1}$ fb. straw mulch 10 t ha$^{-1}$ fb. one HW. Application of metribuzin 0.7 kg ha$^{-1}$ fb. by two hoeing recorded 44.89 % and 134.86% higher yield than weed free and weedy check, respectively. Significantly maximum net return (504319 RS. ha$^{-1}$) and B:C ratio (4.45) was recorded with application of Metribuzin 0.7 kg ha$^{-1}$ fb. by two hoeing.*

***Keywords*** **:** Dynamics, Grasses, productivity, sedges.

Turmeric (*Curcuma longa* L.), a herbaceous perennial plant, belonging to the family Zinziberaceae, native to tropical Southeast Asia is one of the most valuable spices all over the world. Turmeric, an ancient and sacred spice of India, is a major rhizomatous spice produced and exported from India. In India, it is grown over an area of 194,000 ha with an average production of 971,000 MT and productivity 5 MT per ha (Indian Horticulture data base, 2013). Turmeric forms an important adjuvant in Indian culinary as it lends colour and aromatic flavour to various dishes. Turmeric is widely used as a condiment in the preparation of pickles and curries and as a colouring agent in textiles, food and confectionary industries. Turmeric has long been used in India for the treatment of sprains and inflammatory conditions. Turmeric is largely grown as a rainfed crop during *Kharif* season, takes long time span of about 8 –9 months. Delayed emergence, slow initial growth, poor canopy development of turmeric provides ideal environment for weeds to grow and cover the ground quickly and compete with the crop for nutrients, moisture and space causing considerable yield reduction of about 30-75 percent (Krishnamurthi and Ayyaswamy, 2000). It has been well established that the yield loss from weeds is quite higher (45%) than the pest (30%) and diseases (20%) (Rao, 1983). Turmeric requires weed free condition for a long period for better production of rhizomes. But, weed control by hand weeding becomes expensive, time consuming and laborious. Sometimes, due to scarcity of labour specially during critical stages of crop growth, the yield may be reduced drastically. Hence, the use of herbicides in turmeric production is essential. The effectiveness of each herbicide is determined by the factors like type of weed flora, soil type, organic matter content of the soil, weather conditions etc. Therefore, it is essential to screen the herbicides for their efficacy and to find out specific combination under particular agro-climatic conditions for effective weed control in turmeric production. Keeping all the above factors in view, the present investigation on turmeric was undertaken with the objectives to find out the best weed management practice for turmeric production.

## MATERIALS AND METHODS

A field experiment was conducted at Birsa Agricultural University, Ranchi to find out the effect of weed control methods on weed dynamics and productivity of turmeric during *Kharif* season of 2012-13 and 2013-14. The experimental soil was poor in available nitrogen (176 kg ha$^{-1}$) and potassium (158 kg ha$^{-1}$) and medium in available phosphorus (19 kg ha$^{-1}$). The treatments comprised of metribuzin 0.7 kg ha$^{-1}$ fb. two hoeing (T1), metribuzin 0.7 kg ha$^{-1}$ fb. fenoxaprop 67 g ha$^{-1}$ + metsulfuron 4 g ha$^{-1}$ (T2), metribuzin 0.7 kg ha$^{-1}$ fb. straw mulch 10 t ha$^{-1}$ fb. one hand weeding (HW) (T3), pendimethalin 1.0 kg ha$^{-1}$ fb. two hoeing (T4), pendimethalin 1.0 kg ha$^{-1}$ fb. fenoxaprop 67g ha$^{-1}$ +

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metsulfuron 4 g $ha^{-1}$ (T5), pendimethalin 1.0 kg $ha^{-1}$ fb. straw mulch 10 t $ha^{-1}$ fb. one hand weeding (T6), atrazine 0.75 kg $ha^{-1}$ fb. fenoxaprop 67 g $ha^{-1}$ + metsulfuron 4 g $ha^{-1}$ (T7), atrazine 0.75 kg $ha^{-1}$ fb. straw mulch 10 t $ha^{-1}$ fb. one hand weeding (T8), weed free (hand weeding at 25 & 45 DAP) (T9), and weedy check (T10) in randomized block design with three replications. The variety *Rajendra Sonia* was planted at spacing of 45 X 20 cm with seed rate 20 q $ha^{-1}$ fertilizer 100:60:60 kg N:P:K $ha^{-1}$ and vermicompost 20 q $ha^{-1}$on 27$^{th}$ and 5$^{th}$ June during 2012 and 2013 and harvested on 15$^{th}$and 7$^{th}$March respectively during 2013 and 2014. Full dose of phosphorus and 1/3$^{rd}$ of nitrogen and potash were applied as basal, rest 3/4$^{th}$ of nitrogen and potash were applied in two equal splits at 40 and 90 days after planting (DAP). All the herbicides alone or in mixture were applied with knapsack sprayer fitted with flat-fan nozzle using 600 liters water $ha^{-1}$. Population of weeds and dry weight were recorded at 30 and 60 DAP with the help of quadrant (0.5 x 0.5 m) and then converted into per square meter and these data were analyzed after subjecting to square-root (x+0.5) transformation as per Raj *et al.* (2013).

**RESULTS AND DISCUSSION**

The major weed flora found in experimental plot among grasses were *Digitariasanguinalis* (L.) (20%), *Cynodondactylon* Pers. (10%), *Paspalumdisticum*(5%), *Dactylocteniumaegyptium* (L.) (3.5%), *Eleusineindica* Gaerts. (2.5%) and *Echinochloacolona* (L.) Link. (2%) among broad leaved weeds were *Ageratum conyzoides* L. (25%), *Stellaria media* (L.) Vallars (3%), *Heliotropiumesculentum* (2%), *pilanthesacmella* (8%), *Ludwigiaparviflora* (2%), *Commelinanudifolia* (2%) *and Tridexprocumbens* (3%), *Cellosiaargentea* L. (2%). While among sedges the *Cyperusrotundus* L. (7.5%) and *Kyllinga spp*. (2.5%) were dominated. Gill *et al*. (2000) reported the dominance of weed species like *Digitariaischamum, Cynodondactylon, Cyperusrotundus, Eluesineaegypticum, Euphorbia hirta, Commelinabenghalensis* and *Eragrostispilosa* in turmeric. The pooled data of two years revealed that hand weeding at 25 and 45 DAP (T9) recorded reduced density of grassy weeds, broad leaf weeds and sedges at 30 and 60 DAP. Kundu *et al*. (2011) also reported maximum suppression of all the weed density and weed biomass with twice hand weeding at 20 and 40 days after sowing.

Among chemical weed control methods application of metribuzin 0.7 kg $ha^{-1}$ fb. by two hoeing (T1) being similar to metribuzin 0.7 kg $ha^{-1}$ fb. straw mulch 10 t $ha^{-1}$fb. one HW (T3) and pendimethalin 1.0 kg $ha^{-1}$ fb. two hoeing (T4) at 30 DAP while at 60 DAP application of (T4) recorded reduced density of grassy weeds compared to rest of the chemical methods of weed control. Application of metribuzin 0.7 kg $ha^{-1}$ fb. fenoxaprop 67 g $ha^{-1}$ + metsulfuron 4g $ha^{-1}$ (T2) being similar to pendimethalin 1.0 kg $ha^{-1}$ fb. fenoxaprop 67 g $ha^{-1}$ + metsulfuron 4 g $ha^{-1}$ (T5) at 30 and 60 DAP and also application of atrazine 0.75 kg $ha^{-1}$ fb. straw mulch 10 t $ha^{-1}$ fb. one hand weeding (T8) at 60 DAP recorded reduced broad leaf weed density. Significantly reduced density of sedges was observed by application of pendimethalin 1.0 kg $ha^{-1}$ fb. two hoeing (T4) which was similar to other chemical methods of weed control except metribuzin 0.7 kg $ha^{-1}$ fb. fenoxaprop 67g $ha^{-1}$ + metsulfuron 4g $ha^{-1}$ (T2), pendimethalin 1.0 kg $ha^{-1}$ fb. fenoxaprop 67 g $ha^{-1}$ + metsulfuron 4 g $ha^{-1}$ (T5), pendimethalin 1.0 kg $ha^{-1}$ fb. straw mulch 10 t $ha^{-1}$fb. one hand weeding (T6) and atrazine 0.75 kg $ha^{-1}$ fb. straw mulch 10 t $ha^{-1}$ fb. one hand weeding (T8). The pooled data of two years revealed that hand weeding at 25 and 45 DAP (T9) being similar to application of pendimethalin 1.0 kg $ha^{-1}$ fb. two hoeing (T4) at 30 and 60 DAS recorded reduced weed dry matter accumulation as compared to rest of the treatments. Among chemical methods of weed control application of pendimethalin 1.0 kg $ha^{-1}$ fb. two hoeing (T4) being similar to metribuzin 0.7 kg $ha^{-1}$ fb. by two hoeing(T1), pendimethalin 1.0 kg $ha^{-1}$ fb. fenoxaprop 67g $ha^{-1}$ + metsulfuron 4 g $ha^{-1}$ (T6) at 30 DAP and also metribuzin 0.7 kg $ha^{-1}$ fb. straw mulch 10 t $ha^{-1}$ fb. one HW (T3), pendimethalin 1.0 kg $ha^{-1}$ fb. straw mulch 10 t $ha^{-1}$ fb. one hand weeding (T6) and atrazine 0.75 kg $ha^{-1}$ fb. straw mulch 10 t $ha^{-1}$ fb. one hand weeding (T8) at 60 DAP recorded reduced weed dry matter compared to rest of the treatments as well as higher weed control efficiency (93.59 and 93.73 per cent respectively). The reduction in weed dry matter owing to application of metribuzine can be understood by its mode of action as it inhibits photosynthetic electron flow between the primary and secondary electron acceptor of photosystem II (Q and plastoquinone). Similarly pendimethalin inhibits root and shoot growth. It controls the weed population and prevents weeds from emerging, particularly during the crucial development phase of the crop. Fenoxaprop prevents plant cell division and elongation in susceptible species. besides fatty acid synthesis inhibition in grasses, by inhibition of acetyl CoA carboxylase (ACCase). Application of metribuzin 0.7 kg $ha^{-1}$ fb. by two hoeing (T1) being similar to application of atrazine 0.75 kg $ha^{-1}$ fb. straw mulch 10 t $ha^{-1}$ fb. one HW (T8) and hand weeding at 25 and 45 DAP (T9) recorded m maximum leaf area index.

Application of metribuzin 0.7 kg $ha^{-1}$ fb. by two hoeing (T1) recorded 30.98 % and 57.42% higher yield than weed free and weedy check, respectively. However, it was similar to application of metribuzin 0.7 kg $ha^{-1}$ fb. straw mulch 10 t $ha^{-1}$ fb. one HW (T3), pendimethalin

**Table 1:Effect of weed control methods on weed density (no. $m^{-2}$), weed dry matter (g $m^{-2}$) and weed control efficiency in turmeric ((pooled of two years).**

| Treatments | | Weed density (no. $m^{-2}$) | | | | | | | | Weed dry matter ($gm^{-2}$) | | Weed control efficiency | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 30 DAP | | | | 60 DAP | | | | | | | |
| | | Grasses | Broad leaved | Sedges | Total | Grasses | Broad leaved | Sedges | Total | 30 DAP | 60 DAP | 30 DAP | 60 DAP |
| T1 | Metr.fb. H. | 3.37 (11.00) | 5.11 (26.33) | 1.70 (2.83) | 5.53 (34.50) | 3.76 (14.33) | 4.44 (19.67) | 1.71 (3.33) | 6.15 (37.33) | 3.60 (12.90) | 5.06 (25.70) | 86.74 | 4.12 |
| T2 | Metr.fb. H. fb. F. +Met. | 4.68 (21.83) | 3.39 (11.33) | 4.09 (20.17) | 6.06 (40.33) | 5.02 (24.83) | 3.13 (9.33) | 4.98 (30.17) | 7.88 (64.33) | 5.47 (35.15) | 7.54 (61.46) | 65.36 | 2.61 |
| T3 | Metr.fb. Str.M. fb. HW | 3.62 (12.83) | 4.68 (21.50) | 2.16 (4.83) | 5.39 (29.67) | 2.60 (6.67) | 4.90 (23.50) | 2.57 (6.17) | 6.06 (36.33) | 4.75 (22.25) | 5.34 (29.13) | 78.29 | 3.15 |
| T4 | P. fb. Two hoeing | 4.00 (15.67) | 5.64 (31.67) | 1.19 (1.00) | 4.96 (33.67) | 1.70 (2.83) | 4.07 (16.33) | 1.12 (0.83) | 4.46 (20.00) | 2.54 (6.31) | 3.57 (13.28) | 93.59 | 2.56 |
| T5 | P.fb. F. +M. | 5.05 (25.00) | 4.43 (19.17) | 4.45 (21.00) | 6.75 (51.50) | 5.65 (32.00) | 3.37 (11.00) | 6.92 (53.17) | 9.63 (96.17) | 6.38 (41.89) | 10.09 (106.39) | 56.96 | 1.72 |
| T6 | P fb.Str. M. fb. H.W. | 4.39 (18.83) | 4.69 (21.50) | 1.41 (1.50) | 5.31 (31.00) | 2.48 (5.67) | 4.60 (21.17) | 2.10 (4.00) | 5.56 (30.83) | 3.83 (14.25) | 5.35 (28.29) | 85.65 | 2.18 |
| T7 | Atr. fb. F.+ M | 5.00 (24.50) | 4.58 (20.67) | 4.38 (19.33) | 6.98 (52.50) | 5.82 (34.00) | 4.30 (18.00) | 7.14 (53.17) | 10.23 (105.17) | 6.82 (46.59) | 10.60 (113.88) | 52.67 | 1.74 |
| T8 | A.tr. fb. Str. M. fb. H. W. | 4.42 (19.33) | 3.44 (11.50) | 1.52 (2.17) | 4.67 (25.67) | 4.23 (17.50) | 4.48 (19.67) | 2.29 (5.33) | 6.53 (42.50) | 4.79 (23.67) | 6.04 (37.76) | 75.51 | 3.60 |
| T9 | H.W. ( 25 & 45 DAS) | 2.96 (8.50) | 2.97 (8.33) | 0.71 (0.00) | 3.10 (12.00) | 1.34 (1.33) | 2.73 (7.00) | 0.98 (0.50) | 3.05 (8.83) | 1.35 (1.62) | 2.19 (4.41) | 98.33 | 3.72 |
| T10 | W.C. | 6.83 (46.33) | 6.60 (43.67) | 2.6 (5.17) | 9.31 (86.17) | 10.35 (107.67) | 11.31 (127.50) | 3.58 (14.17) | 15.80 (249.33) | 10.10 (101.89) | 14.20 (201.73) | 0.00 | 0.90 |
| | **S Em(±)** | **0.28** | **0.35** | **0.63** | **0.71** | **0.47** | **0.31** | **0.84** | **0.66** | **0.70** | **0.86** | **7.76** | **6.51** |
| | **LSD(0.05)** | **0.84** | **1.04** | **1.88** | **2.10** | **1.39** | **0.91** | **2.50** | **1.95** | **2.08** | **2.57** | **23.04** | **19.34** |

*Note: Data in parentheses are original values.*

**Table 2: Effect of weed control methods on leaf area index, phytotoxicity, yield and economics of turmeric (Pooled)**

| Treatments | | leaf area index ($Cm^2$ $m^{-2}$) | Phytotoxicity (on scale) 10 | Cost of cultivation (RS. $ha^{-1}$) | Yield (t $ha^{-1}$) | Gross return (RS. $ha^{-1}$) | Net return (RS. $ha^{-1}$) | B:C |
|---|---|---|---|---|---|---|---|---|
| T1 | Metr.fb. H. | 4.12 | 2 | 113100 | 24.66 | 616519 | 503419 | 4.45 |
| T2 | Metr.fb. H. fb. F. + Met. | 2.61 | 8 | 110396 | 8.36 | 208931 | 98536 | 0.89 |
| T3 | Metr.fb. Str.M. fb. HW | 3.15 | 2 | 118100 | 21.81 | 545139 | 427039 | 3.62 |
| T4 | P. fb. Two hoeing | 2.56 | 6 | 112632 | 20.34 | 508488 | 395856 | 3.52 |
| T5 | P.fb. F. +M. | 1.72 | 8 | 109928 | 10.04 | 251157 | 141230 | 1.28 |
| T6 | P fb.Str. M. fb. H.W. | 2.18 | 6 | 117632 | 18.92 | 472833 | 355201 | 3.02 |
| T7 | Atr. fb. F.+ M | 1.74 | 8 | 109146 | 13.16 | 329025 | 219880 | 2.01 |
| T8 | A.tr. fb. Str. M. fb. H. W. | 3.60 | 2 | 135250 | 23.84 | 595834 | 460584 | 3.41 |
| T9 | H.W.( 25 & 45 DAS) | 3.72 | 0 | 119700 | 17.02 | 425476 | 305776 | 2.56 |
| T10 | W.C. | 0.90 | 0 | 105700 | 10.50 | 262500 | 156800 | 1.48 |
| **SEm(±)** | | **0.28** | | | **2.51** | **62827.08** | **4752.03** | **0.05** |
| **LSD(0.05).** | | **0.83** | | | **7.47** | **186647.57** | **14117.39** | **0.16** |

1.0 kg $ha^{-1}$ fb. two hoeing (T4), pendimethalin 1.0 kg $ha^{-1}$ fb. straw mulch 10 t $ha^{-1}$ fb. one HW (T6) and atrazine 0.75 kg $ha^{-1}$ fb. straw mulch 10 t $ha^{-1}$ fb. one HW (T8). Higher turmeric yield were in tune with higher weed control efficiency caused by application of metribuzine or pendimethaline integrated with hoeing or straw mulch. Gill *et al.* (2000) as well as Singh *et al.* (2002) also reported similar findings.

Application of metribuzin 0.7 kg $ha^{-1}$ fb. by two hoeing (T1) recorded higher gross return (616519 ¹ $ha^{-1}$) and was equal with application of metribuzin 0.7 kg $ha^{-1}$ fb. straw mulch 10 t $ha^{-1}$ fb. one HW (T3), pendimethalin 1.0 kg $ha^{-1}$ fb. two hoeing (T4), pendimethalin 1.0 kg $ha^{-1}$ fb. straw mulch 10 t $ha^{-1}$ fb. one HW (T6) and atrazine 0.75 kg $ha^{-1}$ fb. straw mulch 10 t $ha^{-1}$ fb. one HW (T8) than rest of the treatments. Similarly, application of metribuzin 0.7 kg $ha^{-1}$ fb. by two hoeing (T1) recorded 68 percent higher net return (50,3419 ha) and B:C ratio (4.45) than rest of the chemical methods of weed control. The higher net return was as a result of 48.21 per cent higher yield and 2.62 per cent reduced cost of cultivation compared to mean yield and cost of cultivation recorded by rest of the chemical methods of weed control.

Herbicide showing more phytotoxicity based on scale 10 was observed by the treatments metribuzin 0.7 kg $ha^{-1}$ fb. fenoxaprop 67 g $ha^{-1}$ + metsulfuron 4 g $ha^{-1}$ (T2), pendimethalin 1.0 kg $ha^{-1}$ fb. fenoxaprop 67 g $ha^{-1}$ + metsulfuron 4 g $ha^{-1}$ (T5), and atrazine 0.75 kg $ha^{-1}$ fb. fenoxaprop 67 g $ha^{-1}$ + metsulfuron 4 g $ha^{-1}$ (T7) having 8 and minimum in application of metribuzin 0.7 kg $ha^{-1}$ fb. by two hoeing (T1) and application of metribuzin 0.7 kg $ha^{-1}$ fb. straw mulch 10 t $ha^{-1}$ fb. one HW (T3) and atrazine 0.75 kg $ha^{-1}$fb. straw mulch 10 t $ha^{-1}$fb. one HW (T8) having 2. It is clear that treatments containing fenoxaprop ethyl and metsulfuron recorded maximum phytotoxicity compared to treatments having no these herbicides. Wasana *et al.* (2006), have also reported phytotoxicity by fenoxaprop-p-ethyl and 2,4-D mixture in rice crop.

Among various weed control methods application of metribuzin 0.7 kg *$ha^{-1}$* fb. by two hoeing was most productive as well as profitable for turmeric cultivation.

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