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Original Research Article

Effect of Integrated Weed Management on Quality Attributes of Turmeric Rhizomes (*Curcuma longa* L.)

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A B S T R A C T

A field experiment was conducted at Birsa Agricultural University, Ranchi during kharif season of 2014 to study the efficacy of pre and post-emergence herbicides in integrated weed management on weed dynamics and quality attributes of turmeric. Among the weed management treatments imposed, at 90 and 150 DAP, metribuzin 0.7kg/ha pre-emergence (PE) followed by (f.b.) fenoxaprop-p-ethyl 67g/ha + metsulfuron 4g/ha at 45 DAP recorded reduced total weed density i.e., 66.96 and 54.67% with higher phyto-toxicity i.e., 7.67 in turmeric plants. On the other hand, atrazine 0.75kg/ha PE f.b. straw mulch at 10 DAP f.b. hand weeding at 75 DAP also recorded significantly lower weed dynamics with low phyto-toxicity i.e., 0.67 in turmeric plants. Similarly, application of atrazine 0.75 kg/ha PE f.b. straw mulch at 10 DAP f.b. hand weeding at 75 DAP recorded higher curing percentage, curcumin content, protein percentage, oil percentage and oil yield. Thus, it can be concluded that application of atrazine 0.75 kg/ha PE f.b. straw mulch and hand weeding at 75 DAP may be practiced for higher quality of turmeric rhizomes owing to better weed control.

Keywords

Curing %, Curcumin %, phyto-toxicity, Protein %, Oil %, Total weed density

Introduction

Turmeric (Curcuma longa L.) is one of the oldest, most important and valuable herb spice to humankind. It has been used traditionally since 600 B.C., as food flavouring, as a dye, in folk medicines and for religious and ritual ceremonies. India is the largest producer of turmeric supplying 94% of the world's demand, consumer and exporter of turmeric in the world market, having an area of 194 (000'ha) with average production of 971 (000' MT) and the productivity is 5 MT/ha (Anon, 2013). Curcumin- the yellow colouring pigment present in rhizome is gaining importance with ban on artificial colours in food industry and demand growth of turmeric is around 10 % pointing to future prospects of turmeric cultivation in the country. Though, India leads in production of turmeric with 78 % of global production, its average productivity is quite low, mainly due to the competition offered by weeds which causes yield lose up to 63.9-76.5% (Kaur *et al.*, 2008) in turmeric owing to also reduction in curcumin content and oil %. Turmeric is a long duration crop. Delayed emergence, slow initial growth of the crop and ample land space available due to wider spacing permit more sunlight to reach the soil resulting in conducive environment for rapid

weed growth and enormous damage to crop yield. Farmers are usually perform hand weeding in turmeric crop but chemical weed control is a better supplement to conventional method and forms an integral part of the modern crop production. It is quick, more effective, time and labour saving method than others (Tahir *et al.*, 2009). But the information related to chemical method of weed control in turmeric is meager and no single method of weed control can control all types of weeds in a particular situation. Hence, combination of other weed control methods as well as combination of other herbicides with appropriate dose and time of application is required for maximum weed control efficiency. Based on the above facts, a field experiment was carried out during *kharif* 2014 at agronomical research farm of Birsa Agricultural University, Ranchi, Jharkhand and we are taken the objective to study the efficacy of pre and post-emergence herbicides in integrated weed management on quality attributes of turmeric.

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 2014. The experimental soil was acidic in nature (pH 5.9), low in organic carbon (4.2 g/ka) and nitrogen (243 kg/ha) while medium in available phosphorus (19.15 kg/ha) and potassium (188.16 kg/ha). The experiments were laid out in randomized block design comprised of fifteen treatments replicated thrice, T_1, T_2, T_3, T_4, T_5, T_6 and T_7 as integration of chemical and hand weeding i.e., metribuzin 0.7 kg/ha or pendimethalin 1.0 kg/ha or atrazine 0.75 kg/ha or oxyfluorfen 0.3 kg/ha or oxadiargyl 0.25 kg/ha PE or glyphosate 1.25 l/ha or glyphosate 1.85 l/ha PoE each *f.b.* 2 hand weeding at 45 and 75 DAP respectively; T_8, T_9 and T_{10} integrated with metribuzin 0.7 kg/ha or pendimethalin 1.0 kg/ha or atrazine 0.75 kg/ha PE each *f.b.* fenoxaprop-p-ethyl 67g/ha + metsulfuron 4 g/ha at 45 DAP respectively; T_{11}, T_{12} and T_{13} integrated with metribuzin 0.7 kg/ha or pendimethalin 1.0 kg/ha or atrazine 0.75 kg/ha PE each *f.b.* straw mulch at 10 DAP *f.b.* hand weeding at 75 DAP respectively; T_{14} and T_{15} as hand weeding at 25, 45 and 75 DAP and un-weeded check respectively. The variety '*Rajendra Sonia*' was planted at spacing of 45 X 20 cm with seed rate 20 q/ha, fertilizer N: P: K:: 120: 60: 100 kg/ha and F.Y.M. 5 tone/ha. All the herbicides alone or in mixture were applied with knapsack sprayer fitted with flat-fan nozzle using 600 litres water/ha. Population of weeds and dry weight were recorded at 30, 90 and 150 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).

Visual ratings of phyto-toxicity were made as given by Samtani (2007) through one to ten points scale.

Curcumin percentage by Manjunath *et al.*, 1991 was calculated as per the standard formulae.

$$\text{Curcumin content (\% by weight)} = \frac{00.25 \times \text{Absorbance} \times 100 \times 100 \text{ of sample}}{\text{Absorbance} \times \text{Weight of} \times 5 \text{ of sample sample (gm)}}$$

$$\text{Curing (\%)} = \frac{\text{Dry weight of rhizome after curing}}{\text{Fresh weight of rhizome (g)}} \times 100$$

The essential oil content from rhizome was extracted by water distillation with the help

of Coking and Middleton apparatus using petroleum ether. Total nitrogen content was determined by Kjeldahl's method. Thereafter, Protein content in rhizomes was estimated by multiplying the nitrogen content with 6.25 factors.

Results and Discussion

Quality attributes of turmeric like curing percentage, curcumin content, protein percentage, oil percentage and oil yield are the reflective processes of effective utilization of resources in a better crop production environment. Conducive crop growth environment with minimum stresses due to biotic factors like lesser weed competition reflects further on better quality attributes of crops. The variations in quality attributes of turmeric was noticed due to different weed control methods primarily associated with change in weed flora composition with varying weed density and weed dry weight.

Total Weed Density

Among chemical weed control methods application of glyphosate 1.85 l/ha PoE at 25 DAP *f.b.* 2 hand weeding at 45 and 75 DAP recorded significantly reduced total weed density at 30 DAP to the extent of 14.22 % compared to hand weeding at 25, 45 and 75 DAP while at 90 and 150 DAP metribuzin 0.7 kg/ha PE *f.b.* fenoxaprop-p-ethyl 67g/ha + metsulfuron 4 g/ha at 45 DAP recorded 66.96 and 54.67 % reduced total weed density compared to hand weeding at 25, 45 and 75 DAP respectively.

Phyto-toxicity (0-10 scale)

Plant injury of turmeric as a result of phyto-toxicity recorded at 60 DAP was maximum under treatments of integration of chemicals like metribuzin 0.7 kg/ha *f.b.* fenoxaprop-p-ethyl 67g/ha + metsulfuron 4 g/ha at 45 DAP i.e., 7.67, at a scale of 0-10. The possible cause can be attributed to treatments with overloaded herbicides combination might have interacted with turmeric plant's delicate tissues resulting epinasty, hyponasty, tip chlorosis, leaf margin scorching and finally whole or partial plant drying. The phyto-toxic effect of herbicide on turmeric plants have also been observed by Bharty *et al.,* (2016a), Barla *et al.,* (2015) and Jadhav and Pawar (2014). Among all the treatments, integration of chemical along with straw mulch and hand weeding recorded reduced phyto-toxicity on turmeric plant i.e., atrazine 0.75 kg/ha PE each *f.b.* straw mulch at 10 DAP *f.b.*hand weeding at 75 DAP. It appears that application of straw mulch as well as hand weeding at 45 DAP might have given selective stimulation advantage to crop over weeds. Thus, plants were strong enough to tolerate herbicidal effect.

Quality attributes

Curing improves qualitative characters of turmeric rhizomes which decide its market price because of more shining and solid rhizome. The curing percent was maximum under atrazine 0.75 kg/ha PE *f.b.* straw mulch at 10 DAP *f.b.* hand weeding at 75 DAP to the extent of 5.38% compared to hand weeding at 25, 45 and 75 DAP.

However, the un-weeded check registered lowest curing percentage. The curcumin content of turmeric rhizome ranged from as low as 5.54 % under un-weeded check to as high as 7.00 % under atrazine 0.75 kg/ha PE *f.b.* straw mulch at 10 DAP f.b. hand weeding at 75 DAP. Application of atrazine 0.75 kg/ha PE *f.b.* straw mulch at 10 DAP *f.b.* hand weeding at 75 DAP recorded 5.9 % higher curcumin content compared to hand weeding at 25, 45 and 75 DAP.

Table.1 Qualitative parameters of turmeric rhizomes as influenced by weed control methods

Treatments	Curing (%)	Curcumin content (%)	Protein (%)	Oil (%)	Oil yield (t ha^{-1})
T1- Metribuzin 0.7 kg ha^{-1} PE f.b. 2 H.W. at 45 and 75 DAP	21.70	6.71	5.70	3.81	0.80
T2- Pendimethalin 1.0 kg ha^{-1} PE f.b. 2 H.W. at 45 and 75 DAP	21.14	6.58	5.51	3.62	0.68
T3- Atrazine 0.75 kg ha^{-1} PE f.b. 2 H.W. at 45 and 75 DAP	21.58	6.68	5.62	3.74	0.77
T4- Oxyfluorfen 0.3 kg ha^{-1} PE f.b. 2 H.W. at 45 and 75 DAP	18.60	6.49	5.41	3.45	0.55
T5- Oxadiargyl 0.25 kg ha^{-1} PE f.b. 2 H.W. at 45 and 75 DAP	18.48	6.44	5.40	3.41	0.52
T6- Glyphosate 1.25 l ha^{-1} at 25 DAP f.b. 2 H.W. at 45 and 75 DAP	19.59	6.54	5.48	3.58	0.66
T7- Glyphosate 1.85 l ha^{-1} at 25 DAP f.b. 2 H.W. at 45 and 75 DAP	19.50	6.50	5.46	3.56	0.65
T8- Metribuzin 0.7 kg ha^{-1} PE f.b. fenoxaprop-p-ethyl 67 g ha^{-1} + metsulfuron 4 g ha^{-1} at 45 DAP	18.05	6.21	5.24	3.21	0.24
T9- Pendimethalin 1.0 kg ha^{-1} PE f.b. fenoxaprop-p-ethyl 67 g ha^{-1} + metsulfuron 4 g ha^{-1} at 45 DAP	17.22	6.18	5.22	3.17	0.18
T10- Atrazine 0.75 kg ha^{-1} PE f.b. fenoxaprop-p-ethyl 67 g ha^{-1} + metsulfuron 4 g ha^{-1} at 45 DAP	16.51	6.10	5.21	3.11	0.10
T11-Metribuzin 0.7 kg ha^{-1} PE f.b. straw mulch at 10 DAP f.b. H.W. at 75 DAP	22.41	6.87	6.10	4.10	1.15
T12- Pendimethalin 1.0 kg ha^{-1} PE f.b. straw mulch at 10 DAP f.b. H.W. at 75 DAP	22.40	6.78	5.90	4.01	1.04
T13- Atrazine 0.75 kg ha^{-1} PE f.b. straw mulch at 10 DAP f.b. H.W. at 75 DAP	22.71	7.00	6.30	4.20	1.22
T14- Hand Weeding at 25, 45 and 75 DAP	21.55	6.61	5.54	3.67	0.71
T15- Un- weeded check	15.93	5.54	5.20	3.04	0.09
SEm±	**0.75**	**0.05**	**0.12**	**0.07**	**0.04**
CD (P = 0.05)	**2.17**	**0.15**	**0.34**	**0.20**	**0.10**
CV%	**6.55**	**1.41**	**3.66**	**3.39**	**9.94**

Fig.1 Effect of weed management practices on total weed density (no./m^2) of turmeric

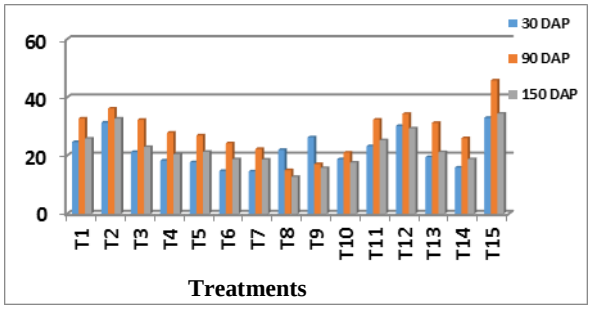
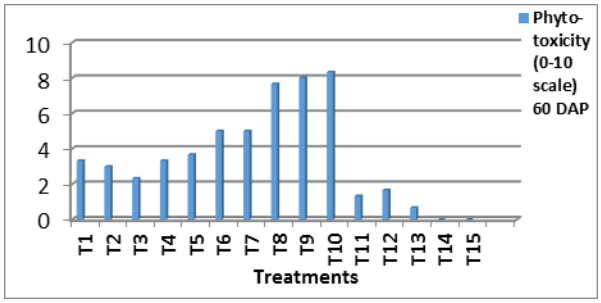


Fig.2 Effect of weed management practices on phyto-toxicity (0-10 scale) of turmeric plant



The protein percentage was also maximum under atrazine 0.75 kg/ha PE *f.b.* straw mulch at 10 DAP *f.b.* hand weeding at 75 DAP to the tune of 13.71 % compared to hand weeding at 25, 45 and 75 DAP and minimum under un-weeded check.

Similarly, oil content of turmeric ranged from as low as 3.04 % under un-weeded check to as high as 4.20 % under atrazine 0.75 kg/ha PE *f.b.* straw mulch at 10 DAP *f.b.* hand weeding at 75 DAP. Application of atrazine 0.75 kg/ha PE *f.b.* straw mulch at 10 DAP *f.b.* hand weeding at 75 DAP continued to record higher oil percentage to the extent 14.44 % compared to hand weeding at 25, 45 and 75 DAP. There was marked reduction in oil content of rhizome wherever metribuzin or pendimethalin or atrazine followed by fenoxaprop-p-ethyl and metsulfuron were applied. The possible cause can be as underdeveloped rhizome due to severe phyto-toxicity. The oil yield is a function of yield and oil content in turmeric rhizome. Oil yield was maximum under atrazine 0.75 kg/ha PE *f.b.* straw mulch at 10 DAP *f.b.* hand weeding at 75 DAP to the tune of 71.83 % compared to hand weeding at 25, 45 and 75 DAP and minimum under un-weeded check. The higher oil synthesis is directly associated with carbohydrate assimilation as a result of photosynthetically active leaves involved in greater dry matter accumulation. However, in case of all the quality attributes the next effective treatments are metribuzin 0.7 kg/ha PE *f.b.* straw mulch at 10 DAP *f.b.* hand weeding at 75 DAP and pendimethalin 1.0 kg/ha PE f.b. straw mulch at 10 DAP f.b. hand weeding at 75 DAP. The higher quality attribute owing to integration with metribuzin 0.7 kg/ha or pendimethalin 1.0 kg/ha or atrazine 0.75 kg/ha PE each *f.b.* straw mulch at 10 DAP *f.b.* hand weeding at 75 DAP can be justified as combined effect of better weed control and reduced phyto-toxicity. These results in respect of quality attributes were in close conformity with the earlier findings of

Manhas *et al.*, (2011), also observed higher oil and curcumin yield of turmeric under the treatments having straw mulch which was significantly higher than no mulch.

Thus, it can be concluded that application of atrazine 0.75 kg/ha PE *f.b.* straw mulch and hand weeding at 75 DAP may be practiced for higher quality of turmeric rhizomes owing to better weed control.

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