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Prashant Singh
Department of Agronomy, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Ravi Shanker Singh
Department of Agronomy, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Dinesh Kumar
Department of Soil Science & Agril. Chemistry, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Rajesh Kumar
Department of Agronomy, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Sanjay Kumar
Department of Agronomy, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Mahendra Pratap Singh
Department of Agronomy, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Gajendra Singh
Department of Agronomy, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Corresponding Author:
Prashant Singh
Department of Agronomy, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, Uttar Pradesh, India

Effect of nitrogen sources and weed management practices on weed dynamics and yield of turmeric

Prashant Singh, Ravi Shanker Singh, Dinesh Kumar, Rajesh Kumar, Sanjay Kumar, Mahendra Pratap Singh and Gajendra Singh

Abstract
The field experiment was conducted to study the studies on nitrogen sources and weed management practices on turmeric with variety NDH-1, at agronomy research farm, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhaya in during *Kharif* season of 2016-17 and 2017-18. The experiment laid out in split plot design with three nitrogen sources (N_1-100% RDN through inorganic fertilizer, N_2-100% RDN through FYM 24 t ha^{-1}, and N_3-100% RDN through vermicompost 6t ha^{-1}) as main plot and four weed management practices (W_1-rice straw mulch 10t ha^{-1}, W_2- manual weeding at 30, 60, 90,120 DAP, W_3-atrazine 700 g ha^{-1} PE and W_4- weedy check) in sub-plot. The observations were recorded on weeds at successive stages of crop growth during both the years. The major weed flora recorded in the experiment was *Echinochloa colona*, *Commelina benghalensis* and *Eleusine indica* among grasses; *Ammania beccifera*, *Ageratum conyzoides*, *Melilotus indica* and *Solanum nigrum* among the broad leaved and *Cyperus rotundus* and *Fimbristyllis dichotoma* in sedges. Different nitrogen management treatments did not affect the weed density and weed dry weight significantly among themselves but plant height, fresh and dry weight of rhizome $plant^{-1}$and rhizome yield ha^{-1}higher in N_3-100% RDN through vermicompost which was significant superior with N_1- 100% RDN through inorganic fertilizer 120 N and at par with N_2- 100% RDN through FYM 10t ha^{-1}. The various weed control treatments were concerned, higher plant height, LAI, yield attribute (fresh and dry weight of rhizome g $plant^{-1}$) with lower value of weed density and dry weight were recorded W_2- manual weeding at 30, 60, 90 and120 DAP followed by W_1-rice straw mulch 10t ha^{-1}. However, weedy check treatment recorded significantly lower values of the entire growth characters plant height, yield and yield attributes and higher values of weed density and weed dry weight over rest of treatment in sub plot. highest weed control efficiency was recorded with Hand weeding at 30, 60, 90 and 120 day after planting (100% and 100.0%) *fb* rice straw mulch 10 t ha^{-1}(69.2% and 66.8%), which was near to comparable with the Hand weeding at 30, 60, 90 and 120 day after planting. However, lowest weed control efficiency was recorded in weedy check (0.0 and 0.0) during both years.

Keywords: Growth, nitrogen, FYM, vermicompost, yield, weed, atrazine and rice straw mulch

Introduction
Turmeric (*Curcuma longa* L.), commonly known as "Indian Saffron", is one of the most important ancient spices of India and is a traditional item of export. India is the leading producer and exporter of turmeric in the world. Andhra Pradesh, Tamil Nadu, Orissa, Karnataka, West Bengal, Gujarat, Meghalaya, Maharashtra and Assam are some of the important states for cultivation of turmeric. Andhra Pradesh alone occupies 38.0 per cent of area and 58.5 per cent production. The turmeric contains moisture (6.0%), protein (6.5%), ash (6.0%), crude fibre (3.0%), starch (5.0%), essential oil (5.9%), curcumin (3-9%), and oleoresin (3-13%). In India, it is grown over an area of 1,85,000 ha with a production of 9,57,000 tonnes and productivity of 5,173 Kg ha^{-1}, respectively (Anonymous, 2016) [1]. Weeds are a big constraint in crop production and they are responsible for heavy yield losses in almost all the crops grown in this region of the country. Turmeric is a long duration crop remains in the field during *Kharif* and *Rabi* both seasons. Hence, the crop severely infested due to weed in both seasons especially during *kharif*. The major weed flora of turmeric crop field is *Echinochloa colona*, *Digitaria sanguinalis*, *Cynodon dactylon*, *Cyperus rotundus*, *Euphorbia hirta*, *Comolina benghlensis*, and *Eragrostis pilosa*. After *kharif* season, frequent irrigations are also required which further create the severe problem of weeds like *Dinebra retroflexa*, *Cyperus rotundus*, *Parthenium hysterophorus*, *Eclipta alba* and *Comolina benghlensis*, thus their management is very important. Hence, it is necessary to establish appropriate nutrient and weed management in turmeric crop based on organic farming to sustain the productivity and quality of turmeric and soil health too. Organic farming is regarded as the best solution to restore our natural resources and to safeguard our environment.

It is a holistic production management system which promotes and enhances agro eco-system health including biodiversity, biological cycles and soil biological activities. Thus, the use of vermicompost is to compensate the recommended dose of fertilizer. Vermicompost is proving to be highly nutritive 'organic fertilizer' and more powerful 'growth promoter' over the conventional composts and a 'protective' farm input (increasing the physical, chemical & biological properties of soil, restoring & improving its natural fertility) against the 'destructive' chemical fertilizers which has destroyed the soil properties and decreased its natural fertility over the years.

Vermicompost is rich in NKP (nitrogen 2-3%, potassium 1.85-2.25% and phosphorus 1.55-2.25%), micronutrients, and beneficial soil microbes and also contain 'plant growth hormones & enzymes' respectively Sinha *et al.* (2009) [9]. It is scientifically proving as 'miracle growth promoter & also plant protector' from pests and diseases.

Material and Methods

The experiment was layout during *kharif*, 2016-17 and 2017-18 at Agronomy Research Farm of Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar, (Kumarganj) Ayodhya (U.P.). The experimental site is situated in main campus of the university, about 42 km away from Ayodhya head quarters. The geographical position of this farm is 26^0 47' N latitude, 82^0 12' E longitude and an altitude of 113 meters above the mean sea level. The experiment field soil was silty loam having OC 0.45% with pH 8.25, EC 0.36 dsm^{-1} and available N 198.0 kg ha^{-1}. The experimental site falls under sub-tropical zone in the Indo-gangatic plains. The region enjoys sub-humid climate receiving a mean annual rainfall of about 1200 mm out of which about 80 per cent is received from mid June to end of September. The experiment was laid out in split plot design (SPD) with three replications having twelve treatments combination. The experimental treatments included three different nitrogen sources (100% RDN through inorganic fertilizer, 100% RDN through FYM 24 t ha^{-1}, and 100% RDN through vermicompost 6 t ha^{-1}) as main plot and four weed management practices (rice straw mulch 10 t ha^{-1}, manual weeding at 30, 60, 90,120 DAP, atrazine 700 g ha^{-1} PE and weedy check) as sub-plot. With an objective to obtain optimum moisture condition for proper germination of seed, a pre-sowing irrigation was applied in the experimental field. At proper tilth, field was ploughed once with tractor drawn soil turning plough followed by cross harrowing with the help of cultivator. There after planking was done to level the field and obtain fine tilth which is necessary for proper germination.

After land preparation the layout of experiment was done on 15th June, 2016 and 11th June, 2017, respectively. Urea, diammonium phosphate (DAP) and muriate of potash (MOP) were used to supply 120 kg N, 50 kg P_2O_5 and 50 kg K_2O ha^{-1}, respectively. One third dose of nitrogen and full dose of phosphorus and potassium were applied as basal dressing and remaining nitrogen was applied in two split doses at 60 and 75 days after planting of the crop during both the years. Well rotten Farm yard manure and Vermicompost as per treatment were computed on fresh weight basis and incorporated uniformly in the plots just before sowing /planting Turmeric. Healthy turmeric rhizomes of uniform size were used as planting material at the rate of 2000 kg ha^{-1}. The planting of crop was done on 22th June, 2016 and 17th June, 2017 in rows at 30 cm and 20 cm plant to plant manually. Adequate soil moisture was maintained at all the stages of crop growth during both year. In all, six irrigations were given in the crop during 2016-17 and 2017-18.

Weed control efficiency of different weeds management practices was calculated on the basis of dry weight accumulated by weeds by the following formula:

$$\mathrm{WCE}(\%) = \frac{\mathrm{WDC} - \mathrm{WDT}}{\mathrm{WDT}} \times 100$$

Where,

WDC = Weed dry weight in weedy check plot

WDT = Weed dry weight in treated plot

The crop was harvested on 16th march, 2017 and 11th march, 2018 during first and second season, respectively at full maturity, when the soil moisture was optimum. The plants were pulled out manually with the help of stump spud (khurpi) and spade without damaging the roots from the net plots.

Results and Discussion

Effect on weeds

As far as the total weed count was concerned, the weed density per unit area reduced appreciably due to the different nitrogen sources at all the stages of crop growth. Among them nitrogen management treatments was recorded non-significantly reduce weed density at all growth stage of turmeric crop. Among weed control treatments prove superiority over weedy check at various growth stages during both of the years. Lower weed density was recorded with manual weeding At 30, 60, 90 and 120 DAP followed by rice straw mulch 10t ha^{-1} at all stages of crop growth except at 30 DAP. Where atrazine 700g PE recorded lower weed density then rice straw mulch 10t ha^{-1} only 30 DAP. This might be due to effective control of weeds caused by pre-emergence application of herbicides and paddy straw mulch checked the germination of weeds at early stages of crop and manual weed control methods at different stages was also control the weed population at all stages of crop growth during both of the years. Although, weeds were also controlled due to the POE application but later on second phase of weeds emerged out and caused the competition with the crop. However, during 2017-18 the infestation of weeds was high due to heavy rain than previous year. The results are in agreement with the finding of Manhas *et al.* (2011) [6]; Jadhav and Pawar (2014) [4], Weed dry matter accumulation is directly related to crop yield. Weed dry matter accumulation reduced appreciably due to the different nitrogen sources and weed management practices treatments as compared to weedy check at all the stages of crop growth. Among them nitrogen management treatments was recorded non-significantly reduce weed dry weight at all growth stage of turmeric crop. However, lowest weed dry weight was recorded with manual weeding at 30, 60, 90 and 120 DAP followed by rice straw mulch 10 t ha^{-1}, under all stages except at 30 DAP where atrazine 700g PE recorded lowest weed density then rice straw mulch 10 t ha^{-1} and higher weed dry weight was recorded with weedy check.

This might be because of the fact that weeds were controlled effectively due to very short time interval manual weeding at 30, 60, 90 and 120 DAP stage of crop growth during both the years. Consequently, higher weed dry weight was recorded with weedy check during both the years. Similar results were also reported by Porwal (1995) [8] and Kumar and Reddy (2000). As far as the weed control efficiency (W.C.E. %) was concerned, it was also affected due to various weed control

treatments. Among them substantially higher values of WCE were recorded with manual weeding at 30, 60, 90, and 120 DAP. Significantly higher weed control efficiency (%) was noticed in similar to weed free treatment because of the season long weed free conditions in that treatment. Lower values of WCE were observed during second year over previous year it might be because of the heavy rain are promote weed growth. Results corroborated with the findings of Jaiswal (1994) [5]

Effect on crop

The data given in Table 1 revealed that Plant height of turmeric was affected significantly due to various nitrogen sources treatments at different stages of crop growth during both the years. 100% RDN through vermicompost 6t ha^{-1} recorded higher plant height *fb*100% RDN through FYM 24t ha^{-1} followed by 100% RDN through inorganic fertilizer. This might be because of fact that vermicompost is a nutritive organic fertilizer enriched with plant available forms of macro (Nitrogen, Phosphorus and Potassium) and micro (Iron, Copper, Zinc, etc.) nutrients, beneficial soil microbes; nitrogen-fixing and phosphate solubilizing bacteria, actinomycetes and plant growth regulators like auxins, cytokinins and gibberellins. In addition, composition of vermicompost show antagonistic ability against soil-borne pathogens thereby improving plant health, resulted more plant height of turmeric. Plant height was influenced significantly due to various weed management practices at all stages of crop growth. Tallest plant recorded under manual weeding at 30, 60, 90, and 120 DAP, this might be due to by smothering effect with increasing weeding times resulted efficient weed control.

However, weedy check treatment recorded significantly lower plant height over rest of the weed control treatments during both years similar results were also reported by Verma and Sarnaik (2006) [10]. Dry matter (g plant^{-1}) was affected significantly due to different weed management practices. At all the stages of crop growth, treatments *e.g.* Manual weeding at 30, 60, 90 and 120 DAP recorded higher crop dry matter. This might be due to effective control of weeds led to less crop weed competition for different source of nourishment like nutrients, water, space, light etc. Resulting congenial environment for production and development of root and shoot portion of the turmeric. Similar findings have also been reported by Mannikeri (2006) [7].

Effect on yield

The different yield attributes like fresh weight and dry weight of rhizome plant^{-1} was affected significantly due to different weed management practices. Manual weeding at 30, 60, 90 and 120 DAP having higher fresh weight and dry weight of rhizome plant^{-1} at par with rice straw mulch 10 t ha^{-1} followed by atrazine 700g ha^{-1} followed by lowest fresh weight and dry weight of rhizome plant^{-1} recorded with weedy check. The higher fresh weight and dry weight of rhizome plant^{-1}under manual weeding followed by straw mulch might be due to fact that these practices controlled the weeds in crop field effectively at grand growth period of crop led to least crop-weed competition resulting beneficial effect on yield attributes. The mulch material may provide the favourable micro environment for declining the weed population on one hand and the exudation of some chemicals after its decomposition may be helpful to enhance the growth and dry matter accumulation in the rhizomes of turmeric. Likewise, manual weeding may accelerate the aeration in the roots zone which may be helpful to encourage the yield attributes and yield of turmeric. Similar results were also reported by Pandey *et al.* (2002) and Manhas *et al.* (2011) [6]. The yield of rhizome (t ha^{-1}) was affected significantly due to different weed management practices.

Table 1: Effect of nitrogen source and weed management on growth, yield attributes and yield of turmeric

Treatment	Plant height (cm)		Dry weigh (g plant^{-1})		Weed density		Weed control efficiency (%)		Yield (t ha^{-1})	
	At harvest		At harvest		At harvest		At harvest			
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Nitrogen management										
N_1	80.53	76.68	216.5	212.2	(1083) 33.41	(1120) 33.96	-	-	23.81	22.19
N_2	95.57	88.55	248.6	238.8	(1104) 33.72	(1130) 34.11	-	-	30.10	28.92
N_3	105.9	94.01	267.9	257.2	(1043) 32.79	(1064) 33.12	-	-	31.87	29.57
Sem±	3.54	3.24	9.11	8.79	11.11	11.56	-	-	0.99	0.95
CD at 5%	10.95	9.99	28.10	27.09	NS	NS	-	-	3.08	2.96
Weed management										
W_1	84.26	79.49	254.3	242.3	(746) 27.81	(816) 29.07	69.2	66.8	25.43	23.49
W_2	102.4	97.34	288.7	282.3	(0.0) 0.5	(0.0) 0.5	100	100	36.08	34.94
W_3	78.11	76.62	206.5	210.8	(1452) 38.61	(1594) 39.92	44.9	40.6	18.36	17.99
W_4	51.91	48.35	128.1	124.3	(2328) 48.75	(2382) 49.30	0	0	14.27	13.81
Sem±	2.46	2.22	7.17	6.90	7.66	8.61	69.2	66.8	0.77	0.73
CD at 5%	7.88	7.18	22.94	22.07	22.99	25.822	100	100	2.46	2.32

Manual weeding at 30, 60, 90 and 120 DAP having higher of rhizome (t ha^{-1}) followed by rice straw mulch 10 t ha^{-1} followed by atrazine 700g ha^{-1} followed by lower yield of rhizome (t ha^{-1}) recorded with weedy check. Higher yield of rhizome (t ha^{-1}) under manual weeding might be due to the fact that weed free environment provided by removal of weeds by these practices have increased the translocation of photosynthates from source to sink and hence the fresh rhizome yield was increased. The treatments in which fresh yield of rhizomes was higher also gave the higher values of

dry yield of rhizomes. Minimum yield recorded under weedy check might be due to the fact that high weed population taken up the more quantity of moisture and nutrients from the root zone which ultimately declined rhizomes yield over other weed control treatments.

These results are in confirmatory with the work done by Barooah *et al.* (2010) [2] and Chnnappagoudar *et al*. (2013) [3].

Conclusion

On the basis of two year experimentation, it may be concluded that maximum plant height, plant dry matter pant^{-1}, rhizome yield ha^{-1} and weed control efficiency obtained by W_2-manual weeding at 30, 60, 90 and 120 DAP. However, among themselves weedy check treatment recorded significantly lower plant height, plant dry mater plant^{-1}, rhizome yield ha^{-1} and weed control efficiency both years. Maximum weed density and weed dry weight recorded with weedy check treatment that's why in weedy check treatment decrease rhizome yield significantly to rest treatments it may be due to crop and weed compete among themselves.

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