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INTEGRATED WEED MANAGEMENT IN TARO (*COLOCASIA ESCULENTA* VAR. ANTIQUORUM)

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ABSTRACT

Taro is one of the most important tuber crops grown in India. Cormels and corms can be compared favourably in nutrition form with potatoes and cereals, its leaves are highly nutritious with good amount of protein and vitamins. The field experiment was conducted during the years 2020 and 2021, under All India Co-ordinated Research Project on Tuber Crops at Regional Horticultural Research and Extension Center, Dharwad (Karnataka), India. The experiment was laid out in RCBD design with eight treatments with three replications. The result revealed that the Higher WCE of 75.20 % was achieved with weed control ground cover mat mulching and it was followed by 78.04% with hand weeding at 30 DAP+ Post emergence herbicide at 60 and 90 DAP in their pooled mean. Lower number of grassy weeds count m^2 at 40 DAP was recorded in the treatment Hand weeding at 30 DAP+ Post emergence herbicide at 60 and 90 DAP of 10.62. Significantly lower number of sedges count m^2 at 40 and 80 DAP were recorded in complete weed free -hand weeding at 30, 60 and 90 DAP of 6.34 and 10.64, respectively.

Key words : INM, Weed density, Weed control efficiency. *Colocasia esculenta.*

Introduction

Taro (*Colocasia esculenta var. antiquorum*) is a stem tuber crop that belongs to the family Araceae. It is a most important tuber vegetable of the world and is known as “Great leaved Caladium” or “Elephant ear” in English, “Dasheen” in USA and “Cocoyam” in West Africa. Colocasia is believed to have originated in South East Asian countries including India (Chang, 1958) and Malaysia (Keleny, 1962). Colocasia is one of the few edible species in the genus colocasia and is the most widely cultivated species (Vinning, 2003). Cultivated colocasia is classified as *Colocasia esculenta*, but the species is considered to be polymorphic. There are two botanical varieties of taro (Purseglove, 1972) *viz.* *Colocasia esculenta* var. esculenta and *Colocasia esculenta* var. antiquorum. *Colocasia esculenta* var. esculenta is characterised by the procession of a large cylindrical central corm and very few cormels. It is referred agronomically as the dasheen type of colocasia. On the other hand, *Colocasia esculenta* var. antiquorum, has a small globular central corm, with several relatively large cormels arising from the corm. Plants are perennial but cultivated as annuals, lactiferous and very variable herb with 30-150 cm in height. Leaves are large or rather large, obliquely erect, long petiole, with varying colour and size. Petiole is sheathering at the base, uniformly light or dark green, green with dark streaks or violet, 40-150 cm long. It consists mainly of the leaves with long petiole which arises in a whorl from the apex of the underground corm. Corms are cylindrical with short internodes and few side tubers.

Colocasia cormels and corms can be compared favourably in nutrition form with potatoes and cereals, its leaves are highly nutritious with good amount of protein and vitamins. The tuber of colocasia is rich source of starch (up to 21% of total carbohydrates), protein (above 3%) and minerals *i.e.* 3.9% (Markam *et al.*, 2018). In India, colocasia is chiefly grown for human consumption and is used as food after peeled, sliced, cooked and taken with condiments and adjuncts. Colocasia is mainly cultivated for the edible tubers but the leaves and its young stacks petioles are cooked and also used for making pakoras. In some countries colocasia is used for making fermented products. The pressure cooked taro corms after being passed through strainer are allowed to ferment giving an acidic product called “poi”. Taro flour is used as baby food and also used for making chips. Colocasia (*Colocasia esculenta* L. Schott) is a traditional crop with a long history of cultivation in Asia and the Pacific region. It is widely used as a tuber vegetable in India, whereas it is very closely associated with culture in many of the South Pacific Islands. It ranks third after cassava and yam, in terms of total production, area and consumption (Chukwu and Nwosu, 2008). In global scenario, Africa ranks first in the area and production of colocasia followed by Asia and Oceania. Despite of the importance of this crop, its cultivation anywhere in India is generally a subsistent to semi-commercial crop. In India, the major colocasia growing states are Manipur, Assam, Nagaland, Orissa, Meghalaya, Gujarat, Maharashtra, Kerala, Andhra Pradesh, Tamil Nadu, West Bengal, Uttar Pradesh and Bihar.

Weeds are potentially major constraints in producing higher yield and quality produce in tuber crops as they compete with the roots for applied resources and sometimes weed roots penetrate into the underground storage organs of tuber crops and reduce the quality of produce (Suresh *et al*., 2019). Taro is susceptible to weed growth especially during initial growth phases due to the time gap between planting and sprouting and slower canopy spread in first few months (Ravindran *et al.*, 2010). Weed infestation at the early stage of crop development causes severe yield reduction upto 100% in wide-spaced plantings (Nedunchezhiyan *et al*., 2018). Weeds compete for all available resources both below (water, nutrients, space) and above ground (space, light) and thereby reduce the crop growth and yield. Weeds are alternative hosts to many pests and disease causing organisms. Weeding alone requires more than 30% of the total labour in this crop and it is approximately 150-200 man days/ha (Nedunchezhiyan *et al*., 2018). Manual weeding is expensive, tedious and time consuming where the labour is scarce or where farm size is large. Application of herbicides for weed control as pre or post-emergence can reduce dependency on manual weeding and reduce cost of production and Another alternative to control weeds in a sustainable agricultural system is using synthetic materials or plant residues/waste on the soil, also known as mulching (Marin Guirao *et al*., 2022). One of the materials intensively used as mulch is plastic film. Mulch film improves soil temperature and moisture, providing a suitable environment for enzymes produced by the microorganism community and improving soil productivity. The additional advantage of mulching is improved weed management by preventing weed seed germination and blocking emerging seedlings’ growth. Also, mulching blocks photosynthetically active radiation while allowing the infrared transmission to maintain the soil warm (Akhtar *et al.*, 2018; Monteiro and Santos, 2022; Zhang *et al.*, 2022). The present study was undertaken at All India Coordinated Research Project on Tuber Crops, Dharwad to find out the most effective weed management strategies option in taro.

Materials and Methods

The present investigations on taro were undertaken at Regional Research and Extension Center Dharwad. North Transitional Zone (Zone-III) of Karnataka state. It is located between 15.47^0 North latitude and 74.97^0 East longitudes at an altitude of 615 m above the mean sea level. The soil of experimental site was lateritic red soil in nature. The experimental field was prepared to a fine tilth by deep ploughing and harrowing. The field was ploughed twice before one month of planting and farm yard manure was incorporated at the rate of @ 20 t ha^{-1} at land harrowing and mixed well. Eight treatment consisted T_1 (*Pre emergence herbicide (1 DAP) + **Post emergence herbicide at 45&90 DAP), T_2 (Pre emergence herbicide (1 DAP) + Hand weeding at 45 and 90 DAP), T_3 (Hand weeding at 30 DAP+ Post emergence herbicide at 60 and 90 DAP), T_4 (Sowing cow pea in interspaces and incorporation at 45 DAP + Post emergence herbicide at 90 DAP), T_5 (Mulching with weed control ground cover mat 120 gsm), T_6 (Straw mulching in interspaces), T_7 (Check- Complete weed free -hand weeding at 30, 60 and 90 DAP), T_8 (Control - un weeded plot) were arranged in randomized block design with three replications. The land was prepared by deep ploughing, harrowing and leveling and there after plots were prepared. The calculated quantities of fertilizers were applied to the each plot. The source of nutrients were nitrogen (DAP, Urea), phosphorus (DAP), potash (MOP). Half of nitrogen and whole dose of phosphorus and potash were applied as basal dose before plating of tubers. While the remaining half dose of nitrogen was given in 2 equal split doses, at 45 and 65 days after planting. Healthy tuber selected and planted in the field with the spacing of 60 × 45 cm. Irrigation was given immediately after planting and gap filling was done at 15 days after planting, to maintain the plant population in each plot and light irrigation was given just after gap filling.

*Pre emergence herbicide Quizalofop ethyl@ 75 g a.i. ha^{-1}.

** Post emergence herbicide Glyphosate 41 SL @ 1000 g a.i ha^{-1}.

Results and Discussion

The total weed population differed significantly due to different weed control treatments at all the growth stages (Tables 1, 2 and 3). The study indicated that the highest, lower number of grassy weeds count m^2 at 40 DAP was recorded in the treatment Hand weeding at 30 DAP+ Post emergence herbicide at 60 and 90 DAP of 10.62 and found to be at par with Complete weed free - hand weeding at 30, 60 and 90 DAP of 12.34. While significantly higher grassy weeds count m^2 of 50.39 noticed in Control – (un weeded plot). At 80 DAP and harvest significantly lower number of grassy weeds count m^2 was observed in complete weed free -hand weeding at 30, 60 and 90 DAP of 10.47 and 19.13 respectively, which found to be on par with Mulching with weed control ground cover mat 120 gsm of 18.83 and 23.38 respectively in there pooled mean of two years. Significantly lower number of sedges count m^2 at 40 and 80 DAP were recorded in complete weed free -hand weeding at 30, 60 and 90 DAP of 6.34 and 10.64 respectively, while at harvesting stage significantly lower number of sedges count m^2 observed in Straw mulching in interspaces. Whereas significantly higher number of sedges count m^2 at all growth stages. This results agrees findings of several studies were conducted on weed flora in India which include: maize (Sandhu *et al.*, 1999) in Punjab; potato in

Table 1 : Number of grassy weeds per 1 m^2 at different growth stages of taro as influenced integrated weed management practices in taro.

Treatments	Grassy weeds 40 days			Grassy weeds 80 days			Grassy weeds Harvest		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
T_1	38.77	36.28	37.53	45.73	38.01	41.87	41.44	37.20	39.32
T_2	40.28	37.87	39.08	50.31	41.84	46.07	50.40	45.25	47.82
T_3	10.60	11.96	10.62	33.16	27.54	30.35	53.76	48.26	51.01
T_4	36.04	33.88	34.96	62.88	52.30	57.59	57.12	51.28	54.20
T_5	15.90	14.88	15.39	20.58	17.09	18.83	24.64	22.12	23.38
T_6	25.44	23.92	24.68	34.30	28.53	31.41	36.96	33.18	35.07
T_7	12.72	10.64	12.34	11.43	9.51	10.47	20.16	18.10	19.13
T_8	51.94	48.83	50.39	76.60	63.66	70.13	106.23	95.40	100.82
Mean	**28.96**	**27.28**	**28.12**	**41.87**	**34.81**	**38.34**	**48.84**	**43.85**	**46.34**
S.Em.±	1.55	1.94	1.66	2.41	2.20	2.28	3.03	2.90	2.97
C.D. at 5%	4.70	5.88	5.05	7.31	6.68	6.90	9.19	8.81	9.00
CV %	9.26	12.32	10.25	9.96	10.95	10.28	10.75	11.47	11.09

Table 2 : Number of sedges per 1 m^2 at different growth stages of taro as influenced integrated weed management practices in taro.

Treatments	Sedges 40 days			Sedges 80 days			Sedges Harvest		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
T_1	32.90	30.39	31.64	38.85	42.38	40.62	32.48	28.85	30.66
T_2	28.51	26.44	27.48	29.97	32.69	31.33	35.84	31.83	33.83
T_3	8.77	8.10	8.45	18.87	20.58	19.73	32.48	28.85	30.66
T_4	16.45	15.25	15.85	35.52	38.75	37.13	34.72	30.83	32.78
T_5	8.77	8.14	8.45	14.43	16.95	16.25	14.56	16.91	17.97
T_6	9.87	9.15	9.51	15.54	15.74	15.09	19.04	9.95	10.57
T_7	6.58	6.10	6.34	9.99	11.29	10.64	11.20	12.93	13.75
T_8	35.09	32.90	34.00	58.86	64.33	61.60	115.07	89.21	102.14
Mean	**18.37**	**17.02**	**17.72**	**27.75**	**30.34**	**29.05**	**36.92**	**31.17**	**34.05**
S.Em. ±	1.25	0.95	1.07	1.90	2.56	2.22	2.21	3.28	2.66
C.D. at 5%	3.80	2.88	3.24	5.75	7.75	6.73	6.70	9.96	8.06
CV %	11.80	9.65	10.45	11.83	14.59	13.24	10.36	18.25	13.52

Table 3 : Number of broad leaved weeds per 1 m^2 at different growth stages of taro as influenced integrated weed management practices in taro.

Treatments	Broad leaved weeds 40 days			Broad leaved weeds 80 days			Broad leaved weeds Harvest		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
T_1	20.76	18.24	19.50	32.29	29.32	30.81	17.95	15.78	16.86
T_2	14.99	13.51	14.25	33.40	30.34	31.87	20.34	17.88	19.11
T_3	5.77	5.20	5.48	16.70	15.17	15.93	26.33	23.14	24.73
T_4	9.23	8.31	8.77	20.04	18.20	19.12	29.92	26.30	28.11
T_5	6.92	5.45	3.88	10.02	8.09	8.50	10.77	10.52	11.24
T_6	8.07	6.23	6.58	13.36	9.10	9.56	11.97	7.36	7.87
T_7	2.31	7.27	7.67	8.91	12.13	12.75	8.38	9.47	10.12
T_8	28.83	25.98	27.41	43.42	39.44	41.43	81.13	69.73	75.43
Mean	**12.11**	**11.27**	**11.69**	**22.27**	**20.22**	**21.25**	**25.85**	**22.52**	**24.19**
S.Em. ±	0.67	0.86	0.70	1.07	1.36	1.21	1.37	1.63	1.45
C.D. at 5%	2.02	2.61	2.11	3.23	4.12	3.68	4.14	4.93	4.40
CV %	9.53	13.22	10.30	8.29	11.64	9.89	9.15	12.51	10.38

Table 4 : Weed density at different growth stages of taro as influenced integrated weed management practices in taro.

Treatments	Weed density (1 m^2) 40 days			Weed density (1 m^2) 80 days			Weed density (1 m^2) Harvest		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
T_1	92.43	84.92	88.67	116.87	109.71	113.29	91.87	81.83	86.85
T_2	83.79	77.82	80.80	113.68	104.87	109.27	106.58	94.96	100.77
T_3	25.14	23.97	24.56	68.73	63.29	66.01	112.57	100.25	106.41
T_4	61.72	57.45	59.58	118.44	109.25	113.85	121.76	108.41	115.08
T_5	26.98	28.46	27.72	45.03	42.13	43.58	55.65	49.55	52.60
T_6	42.23	39.30	40.77	58.75	53.37	56.06	56.54	50.49	53.51
T_7	27.37	25.33	26.35	34.78	32.93	33.86	45.49	40.50	42.99
T_8	115.87	107.71	111.79	178.89	167.43	173.16	302.43	254.35	278.39
Mean	**59.44**	**55.62**	**57.53**	**91.90**	**85.37**	**88.63**	**111.61**	**97.54**	**104.58**
S.Em. ±	2.94	3.39	3.07	4.74	5.17	4.94	5.82	7.49	6.63
C.D. at 5%	8.90	10.29	9.31	14.36	15.69	14.99	17.64	22.73	20.11
CV %	8.55	10.56	9.24	8.93	10.49	9.66	9.02	13.31	10.98

Haryana (Punia *et al.*, 2007); rice-wheat system in Indo-Gangetic plains (Singh *et al.*, 2005); soybean in Madhya Pradesh; pointed guard in Assam. There is urgent need to continuously monitor the weed flora in taro cropping systems and agro-ecological regions of Karnataka, to assess the emerging weed problems and to plan weed management strategies for the present and future weed problems in the State.

Lower weed density and dry matter were recorded with weed control ground cover mat mulching at all the growth stages except 40 DAP, which reduced total weed biomass, owing to complete cover of the ground which did not allow weeds to germinate and emerge. It was at par with straw mulching in interspaces at 80 DAP and at Harvest. The total weeds biomass is directly related to weed control efficiency (WCE). The Higher WCE of 75.20% was achieved with weed control ground cover mat mulching and it was followed by 78.04% with hand weeding at 30 DAP+ Post emergence herbicide at 60 and 90 DAP in their pooled mean, because of their lower weed biomass at 40 DAP. While at 80 DAP and at Harvest Significantly Higher WCE of 74.92 and 81.01 per cent respectively was achieved with weed control ground cover mat mulching and it was followed by straw mulching in interspaces (67.38 and 80.68 per cent, respectively) in their pooled mean. Significantly higher weed density (111.79, 173.16 and 278.39 m^{-2} at 40, 80 DAP and harvest stage respectively in their pooled mean) and biomass (14.34, 21.04 and 36.39 g m^{-2} at 40, 80 DAP and harvest stage, respectively in their pooled mean) were recorded in weedy check. Weed index (WI) was ranged from 0.00 to 51.50. Maximum weed index was recorded

Table 5 : Dry matters at different growth stages of taro as influenced integrated weed management practices in taro.

Treatments	Dry matters (g/m^2) (1 m^2) 40 days			Dry matters (g/m^2) (1 m^2) 80 days			Dry matters (g/m^2) (1 m^2) Harvest		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
T_1	11.70	11.16	11.43	13.60	13.23	13.41	11.12	11.00	11.06
T_2	10.61	10.14	10.37	13.57	13.21	13.39	12.90	12.76	12.83
T_3	3.18	3.04	3.11	8.18	7.97	8.08	13.63	13.47	13.55
T_4	7.81	7.47	7.64	14.15	13.77	13.96	14.74	14.57	14.65
T_5	3.42	3.27	3.34	5.36	5.22	5.29	6.74	6.66	6.70
T_6	5.35	5.11	5.23	7.02	6.83	6.93	6.85	6.77	6.81
T_7	3.46	3.31	3.39	4.15	4.04	4.10	5.51	5.44	5.48
T_8	14.67	14.02	14.34	21.31	20.76	21.04	36.59	36.18	36.39
Mean	**7.52**	**7.19**	**7.36**	**10.92**	**10.63**	**10.77**	**13.51**	**13.36**	**13.43**
S.Em. ±	0.37	0.34	0.35	0.70	0.69	0.69	0.85	0.79	0.82
C.D. at 5%	1.13	1.03	1.07	2.13	2.10	2.11	2.58	2.40	2.48
CV %	8.55	8.21	8.29	11.14	11.29	11.17	10.90	10.24	10.54

Table 6 : Weed control efficiency and Weed index at different growth stages of taro as influenced integrated weed management practices in taro.

Treatments	Weed control efficiency 40 days			Weed control efficiency 80 day			Weed control efficiency Harvest			Weed index		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
T_1	20.58	21.55	21.07	34.51	34.28	34.40	69.65	67.63	68.64	38.82	38.23	38.53
T_2	27.67	27.74	27.70	36.03	36.89	36.46	64.79	62.43	63.61	51.84	51.17	51.50
T_3	78.30	77.78	78.04	61.71	62.30	62.01	62.81	60.35	61.58	39.38	38.74	39.06
T_4	46.71	46.66	46.68	33.32	34.19	33.76	59.77	57.12	58.45	43.13	41.38	42.26
T_5	76.70	73.70	75.20	74.92	74.91	74.92	81.62	80.40	81.01	17.24	14.87	16.06
T_6	63.53	63.58	63.56	66.92	67.83	67.38	81.32	80.04	80.68	28.27	26.85	27.56
T_7	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	0.00	0.00	0.00
T_8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	43.14	53.67	48.40
Mean	**51.69**	**51.38**	**51.53**	**50.93**	**51.30**	**51.11**	**64.99**	**63.50**	**64.25**	**32.73**	**33.11**	**32.92**
S.Em.±	1.77	2.86	2.28	1.57	1.53	1.47	3.09	1.88	1.79	4.62	8.11	5.36
C.D. at 5%	5.37	8.68	6.92	4.77	4.65	4.47	9.38	5.69	5.43	14.01	24.59	16.26
CV %	5.93	9.64	7.67	5.35	5.17	5.16	8.24	5.12	6.12	18.56	21.56	22.56

in the weedy check and the effective weed control treatment with lower weed index was weed control ground cover mat mulching (16.06). Better WCE with weed control ground cover mat mulching in elephant foot yam was reported by George and Sindhu (2017), Nedunzhiyan *et al*. (2018); in cassava (Nedunzhiyan *et al*., 2017) and Marin Guirao *et al* (2022).

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