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Effect of Tillage Systems and Integrated Weed Management on Yield and Quality of Summer Cowpea and Soil Fertility

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An experiment was conducted on coastal lateritic soil of Konkan region to study the effect of tillage systems and integrated weed management on yield and quality of summer cowpea, and soil fertility during summer 2011 at Agronomy Department Farm, College of Agriculture, Dapoli. The experiment was laid out in split plot design with three replications. The main plot treatments consisted of tillage systems (T_1 - Zero tillage, T_2 - Strip tillage, T_3 - Minimum tillage, T_4 - Conventional tillage) and the sub plot treatments consisted of weed management treatments (W_0 - Unweeded control, W_1 - Weed free check, W_2 - One hand weeding at 25 DAS, W_3 - Pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1}, W_4 - Combination of W_2 and W3 treatments, W_5 - Integration (one hoeing at 20 DAS + W_2 + W_3). Among the tillage systems studied, conventional tillage and minimum tillage remained at par with each other and both significantly increased the grain and stover yield, N, P_2O_5, K_2O content and their uptake, and protein content in both grain and stover over zero tillage and strip tillage. Among the different treatments tried to contain the weeds, the treatment W1 (weed free check) produced maximum and significantly higher grain and stover yield, N, P_2O_5, K_2O content and their uptake, and protein content in both grain and stover as compared to all other treatments except W5 (integration of pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} with hoeing at 20 DAS and hand weeding at 25 DAS). The soil available nitrogen, phosphorus and potassium measured after harvest of cowpea were not influenced significantly by both tillage systems and weed managements treatments.

(***Keywords:*** *Cowpea, Tillage systems, Weed management, Pendimethalin)*

Cowpea (*Vigna unguiculata* L.) is the most important legume in the world. It is an important source of dietary protein in developing countries of Asia and Africa. It is used as fodder, vegetable pulse and green manure crop. The economic importance of cowpea is difficult to ascertain as the production statistics are no longer kept separate from those of other pulses. Summer cowpea is grown as catch crop in Konkan region in the areas where irrigation facilities are available.

Tillage was considered as an 'art' and in the recent years, research evidence has focused tillage as 'science'. There are various systems of tillage, such as minimum tillage, zero tillage, strip tillage, conventional tillage, etc. From time immemorial various methods of ploughing have been tried by trial and error, based on the labour availability and economic status of the farmer. Tillage is an important aspect regarding crop production as tillage accounts 30 per cent of cost of production. Nowadays, considering the high cost of tillage there is a need to plan suitable tillage system for profitable crop production. The control of weeds has always been one of the greatest resource consuming operations in crop production. In addition to requiring effective control measures, weeds rob crop plants of nutrients and water, often serve as hosts to insects and pests and create problems in harvesting and processing. The selection of a method or methods for controlling weeds is influenced by the type and age of the crop, the type and size of the weeds, time and the equipment available. Good weed management usually involves a combination of the available methods plus timeless and good cultural practices. In this context, the effects of different tillage systems and weed management practices on yield and quality of summer cowpea and soil fertility have been studied in Konkan region of Maharashtra.

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MATERIALS AND METHODS

A field experiment on cowpea (cv. Konkansadabahar) was conducted during summer 2011 at Agronomy Department Farm, College of Agriculture, Dapoli. The soil was sandy clay loam in texture, medium in available nitrogen (302.42 kg ha^{-1}) and phosphorus (12.13 kg ha^{-1}), high in available potassium (271.89 kg ha^{-1}), very high in organic carbon (11.8 g kg^{-1}) and slightly acidic in reaction (pH 6.2). The experiment was laid out in a split plot design with three replications. The main plot treatments were four tillage systems, namely, zero tillage (T_1), strip tillage (T_2), minimum tillage (T_3) and conventional tillage (T_4). The sub plot treatments comprised six integrated weed management treatments viz., unweeded control (W0), weed free check (W_1), one hand weeding at 25 DAS (W_2), pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} (W_3), combination of W_2 and W_3 (W_4) and integration of pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} with hoeing at 20 DAS and hand weeding at 25 DAS (W5). The gross plot size was 4.5 x 3.0 m^2 and net plot size was 3.9 x 2.4 m^2.

The preparatory tillage operations were carried out as per the main plot treatments. The recommended full dose of N and P_2O_5 were applied to each plot at the time of sowing. Healthy, unbroken and well developed seeds of cowpea variety Konkansadabahar were treated with fungicide and inoculated with biofertilizers (Rhizobium + PSB @ 25 g kg^{-1} seeds) before sowing the seeds. The package of practices after sowing was followed as per the treatments, and periodical growth observations were recorded at an interval of 20 days. Crop was harvested at physiological maturity and data on yield attributes and yield were recorded.

RESULTS AND DISCUSSION

Effect of tillage systems on grain and stover yield, N, P and K content and protein content of cowpea

It is evident from the data presented in Table 1 that the conventional tillage produced maximum and significantly higher grain (8.22 q ha^{-1}) and stover yield (19.71 q ha^{-1}) over the rest of the tillage systems except minimum tillage which was at par with conventional tillage. The magnitude of increase in grain yield recorded by conventional tillage over minimum, strip and zero tillage was 1.23, 7.31 and 14.17 per cent, respectively. The per cent increase in grain yield observed under minimum tillage over strip and zero tillage was 6.01 and 12.78, respectively. Increase in yields of conventional and minimum tillage over rest of the tillage systems was due to better growth and yield attributes observed in these treatments. Similar results have been reported by Deibert and Utter (2004) and Adekalu and Okunade (2006).

The highest N, P and K content in grain and stover was observed in conventional tillage as compared to the rest of the tillage systems. Minimum tillage was however, at par with conventional tillage excepting for P content in both grain and stover. This might be due to better absorption of N, P and K by the crop due to their higher availability in the rhizosphere soil pool of conventional and minimum tillage systems. The results are in accordance with the findings of Yano *et al.*, (1995). The protein content of cowpea followed the same trend to that of nitrogen content in grain and stover as protein content is computed by multiplying N content with the factor 6.25.

Effect of weed management

It could be seen from Table 1 that the highest grain (11.07 q ha^{-1}) and stover yields (25.51 q ha^{-1}) of cowpea were recorded when the weeds were controlled by weed free check (W1). Both yields were however, at par with the yields obtained due to the integration of pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} with hoeing at 20 DAS and hand weeding at 25 DAS (W_5). Further, the percentage increase in grain yield recorded in weed free check (W_1) over integration (W_5), combination of W_2 and W_3 (W_4), hand weeding at 25 DAS (W_2), pre-emergence application of pendimethalin @ 1 kg a.i. ha^{-1} (W_3) and unweeded control (W_0) was 0.45, 16.28, 65.72, 123.19 and 210.96 per cent, respectively. The marked improvement in yield was due to the significant improvement in growth parameters which favourably reflected on the yield attributes of the cowpea. This might be due to effective control of weeds and thereby reduced crop weed competition and better crop growth. The results are in agreement with those of Singh and Angiras (2004) and Chattha *et al.*, (2007).

The data presented in Table 1 revealed that weed free check (W_1) to cowpea recorded significantly higher N, P and K content in grain and stover over rest of the treatments and was at par with integration (W_5) except P content in grain and K content in both grain and stover, where combination of W_2 and W_3 (W_4) also remained at par with both these former treatments. Weed free

Table 1. *Grain and Stover yield, N P and K content and Protein content of cowpea as influenced by different treatments*

Treatments	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})	N content (%)		P content (%)		K content (%)		Protein content
			Grain	Stover	Grain	Stover	Grain	Stover	
Tillage systems									
T_1 – Zero tillage	7.20	14.49	3.266	3.266	0.267	0.070	1.017	2.077	20.35
T_2 – Strip tillage	7.66	16.74	3.500	3.500	0.301	0.106	1.094	2.098	21.88
T_3 – Minimum tillage	8.12	19.06	3.678	3.678	0.364	0.166	1.193	2.219	22.99
T_4 – Conventional tillage	8.22	19.71	3.750	3.750	0.398	0.201	1.244	2.248	23.44
F. test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig	Sig.	Sig	Sig.
S.Em. +	0.13	0.60	0.036	0.020	0.005	0.003	0.018	0.019	0.22
C.D. at 5%	0.44	2.08	0.123	0.068	0.019	0.010	0.061	0.065	0.77
Weed management									
W_0: Unweeded Control	3.56	8.40	3.233	1.725	0.278	0.096	1.015	1.885	20.21
W_1: Weed free check	11.07	25.51	3.742	2.077	0.367	0.167	1.200	2.321	23.39
W_2: One hand weeding at 25 DAS	6.68	14.87	3.542	1.928	0.328	0.128	1.143	2.138	22.14
W_3: Pre-emergence application of Pendimethalin @ 1 kg a.i.ha^{-1}	4.96	11.45	3.475	1.870	0.318	0.118	1.126	2.097	21.72
W_4: Combination of W_2 and W_3 treatments	9.52	20.71	3.608	1.968	0.348	0.148	1.158	2.245	22.55
W_5: Integration (One hoeing at 20 DAS+W_2+W_3)	11.02	24.21	3.675	2.026	0.358	0.158	1.183	2.278	22.97
F. test	Sig.	Sig.	Sig.	Sig	Sig.	Sig	Sig.	Sig	Sig.
S.Em. +	0.14	0.48	0.035	0.023	0.009	0.005	0.023	0.028	0.22
C.D. at 5%	0.40	1.37	0.100	0.065	0.024	0.013	0.066	0.079	0.63
Interaction effect									
F. test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
S.Em. +	0.11	1.28	0.007	0.003	0.00	0.00	0.003	0.04	0.27
C.D. at 5%	–	–	–	–	–	–	–	–	–
General mean	7.80	17.52	3.55	1.93	0.33	0.14	1.14	2.16	22.16

Table 2. *N, P and K uptake and soil fertility status as influenced by different treatments*

Treatments	N uptake kgha^{-1}		P uptake kgha^{-1}		K uptake kgha^{-1}		Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
	Grain	Stover	Grain	Stover	Grain	Stover			
Tillage systems									
T_1 - Zero tillage	23.88	27.56	1.99	1.14	7.64	31.26	310.85	13.87	266.03
T_2 – Strip tillage	27.14	32.14	2.39	1.92	8.51	36.17	307.19	13.62	266.95
T_3– Minimum tillage	30.42	38.45	3.05	3.35	9.79	43.12	304.78	13.48	262.67
T_4 – Conventional tillage	31.32	40.78	3.38	4.14	10.32	44.99	302.62	12.80	259.32
F. test	Sig.	Sig.	Sig.	Sig	Sig.	Sig	N.S.	N.S	N.S
S.Em. +	0.49	1.31	0.09	0.08	0.13	1.44	1.92	0.23	1.64
C.D. at 5%	1.70	4.53	0.30	0.28	0.44	4.97	–	–	–
Weed management									
W_0: UnweededControl	11.56	14.75	1.01	0.86	3.69	16.09	308.73	13.84	270.46
W_1: Weed free check	41.46	53.12	4.08	4.36	13.33	59.31	302.62	13.11	258.25
W_2: One hand weeding at 25 DAS	23.73	28.79	2.21	2.02	7.65	31.87	307.19	13.52	265.31
W_3: Pre-emergence application of Pendimethalin @ 1 kg a.i.ha^{-1}	17.31	21.56	1.60	1.43	5.61	24.15	308.42	13.67	267.74
W_4: Combination ofW2 and W3 treatments	34.53	40.91	3.35	3.20	11.08	46.61	305.73	13.43	261.51
W_5: Integration (One hoeing at 20 DAS +W_2+W_3)	40.57	49.21	3.97	3.95	13.02	55.28	305.46	13.09	259.18
F. test	Sig.	Sig	Sig.	Sig	Sig.	Sig.	N.S.	N.S.	N.S.
S.Em. +	0.61	1.06	0.12	0.27	0.29	1.20	3.25	0.21	3.16
C.D. at 5%	1.75	3.03	0.35	0.77	0.83	3.44	–	–	–
Interaction effect									
F. test	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
S.Em. +	2.11	6.36	0.09	0.41	0.48	8.2	59.63	0.24	56.62
C.D. at 5%	–	–	–	–	–	–	–	–	–
General mean	28.19	34.73	2.70	2.64	9.06	38.88	306.36	13.44	263.74

environments could have made more nutrients available to cowpea. These findings corroborate the reports of Kundra *et al.*, (1993).

The protein content of cowpea grain and stover was significantly higher in weed free check (W_1) over rest of the treatments except under integration (W_5). This increase in protein content could be attributed to increased concentration of nitrogen in grain and stover of cowpea under these weed management treatments. Comparatively higher amount of protein in grain and stover could be attributed to higher uptake of nitrogen under weed free check (W_1) and integration (W_5) treatments. These results are in corroboration with those reported by Patel and Thanki (2004) and Dhane *et al.*, (2010).

Effect of tillage system on N, P and K uptake and soil fertility status

The maximum uptake of N, P and K in grain, stover and their total was observed in conventional tillage, which was significantly higher over strip and zero tillage. Minimum tillage was at par with conventional tillage except P uptake in grain, stover and their total and K uptake in grain. These results are in accordance with Smittle and Threadgill (1979). The available N, P_2O_5 and K_2O content of soil after harvest of cowpea due to different tillage systems were not influenced significantly by the treatments. However, there was a little improvement in N and P_2O_5 status compared to their initial levels because of application of these nutrients to the crop, while, K_2O level was depleted as compared to initial level. This might be due to lack of application of K_2O to the crop. Similar results were reported by VedPrakash *et al.*, (2004).

Effect of weed management

Weed free check (W_1) recorded significantly higher N, P and K uptake by grain and stover over rest of the weed management treatments imposed excepting integration (W_5) in N uptake in grain, K uptake in grain and P uptake in both grain and stover and their total, which remained at par with weed free check (W_1). These results are similar to those reported by Kundra *et al.*, (1993).

The available N, P_2O_5 and K_2O content of soil after harvest of cowpea due to weed management treatments was not influenced significantly. However, there was little improvement in N and P_2O_5 status compared to their initial levels under all the weed management treatments as these nutrients were applied to the crop and also due to biological fixation of nitrogen. The K_2O level was depleted under all the weed management treatments compared to initial level as it was not supplied to the crop.

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