Indian Journal of Weed Science **48**(2): 186–190, 2016
DOI: 10.5958/0974-8164.2016.00046.0

Tillage and nitrogen management effects on weed seedbank and yield of fingermillet

Vijaymahantesh, H.V. Nanjappa and B.K. Ramachandrappa[1]
AICRP Dry Land Agriculture, University of Agricultural Science, Bengaluru, Karnataka 560 065

Received: 29 March 2016; Revised: 7 May 2016

ABSTRACT

Field and pot culture studies were conducted at Bengaluru to study the influence of three tillage practices, *viz*. conventional tillage (3 ploughings + 3 inter cultivations), reduced tillage (2 ploughings + 2 inter cultivations) and minimum tillage (1 ploughing + 1 inter cultivation) and three nitrogen management practices, *viz*. 100% N through Urea, 100% N through integrated supply (50% N through urea+ 25% N through FYM+ 25% N through *Glyricidia*) and 100% N through organic source (50% N through FYM+ 50% N through *Glyricidia*) on live weed seedbank and yield of fingermillet (*Eleusine coracana* L.) under rainfed pigeonpea-fingermillet system in Alfisols. The results showed that conventional tillage reduced the infestation of *Borreria articularis, Cynodon dactylon* and *Cyperus rotundus* compared to other tillage practices. However nitrogen management practices didn't influence live weed seed bank significantly. Among tillage practices, conventional tillage recorded significantly higher fingermillet yield (3.03 t/ha) compared to other tillage practices and among nutrient management practices integrated supply of N recorded higher yield of 2.67 t/ha compared to other nutrient management practices. More live weed seeds were distributed in upper 10 cm soil depth in minimum tillage whereas in conventional tillage live weed seed distribution was more or less uniform in the soil profile studied.

Key words: Glyricidia, Grain yield, Finger millet**,** Nitrogen effect, Weed seed bank, Tillage effect

Pigeonpea (*Cajanus cajan* L.) - fingermillet (*Eleusine coracana* L.) system is an important cropping system in Southern India particularly in Karnataka state. Both crops are largely grown under rainfed conditions, experiencing moisture deficiency at different growth stages of growth. Deficiency of moisture for both the crops affects normal growth and development resulting in lesser yield under rainfed conditions. Further nutrient deficiency particularly N and unchecked weed growth inflict considerable reduction in fingermillet yield.

Role of tillage in conserving soil moisture and its subsequent beneficial effect on crop productivity has long been recognized. Adequate tillage operations controlled weeds and resulted in higher crop productivity, but caused more soil loss and were more capital intensive (Dogra *et al*. 2002). Tillage influences the vertical distribution of weed seeds in soil layer and weed diversity. No till cropping systems leave most seeds in top 1.0 cm layer of soil profile (Yenish *et al*. 1992). Differential distribution of seeds in the soil profile subsequently leads to change in weed population dynamics (Buhler 1991). Use of organic manure is inevitable for sustained agricultural production by reducing dependence on inorganic fertilizers and to build the soil fertility and improve the soil biological activity. Keeping this in view, a study was under taken to find out the combined influence of tillage and nitrogen management practices on live weed seedbank and yield of fingermillet under pigeonpea-fingermillet system in *Alfisols* of Southern India.

***Corresponding author:** mahantesh7151@gmail.com
[1]Directorate of Extension, UHS, Bagalkot

MATERIALS AND METHODS

Field experiments were conducted during *Kharif* seasons of 2010 and 2011 at the University of Agricultural Sciences, G.K.V.K, Bengaluru. The soil of the experimental field was red sandy clay loam having a pH 5.5, with 0.36% organic carbon, available N 175 kg/ha, P 68.4 kg/ha and K 160 kg/ha. The treatments consisting of three tillage practices, *viz. c*onventional tillage (3 ploughings + 3 inter cultivations), reduced tillage (2 ploughings + 2 inter cultivations) and minimum tillage (1 ploughing + 1 inter cultivation) in main plots combined with three nitrogen management practices, *viz.* 100% N through Urea, 100% N through integrated supply (50% N through urea + 25% N through FYM+ 25% N through *Glyricidia*) and 100% N through organic sources (50% N through FYM+ 50% N through *Glyricidia*) in sub-plots were replicated thrice in split-plot design. Tillage practices were done as per treatment details *viz.*, in conventional tillage, three ploughings (15-20 cm deep) and three inter cultivations during the crop period was done first after 30 days after sowing and remaining two at an interval of fifteen days. In reduced tillage,two ploughings (15-20 cm deep) and two inter cultivations during the crop period was done, first inter cultivation after 30 days after sowing and remaining one after an interval of fifteen days. In minimum tillage, one ploughing (15-20 cm deep) and one inter cultivations during the crop period was done after 30 days after sowing.

Nitrogen management practices were followed as per the treatment details, *viz.* in 100% N through urea treatment, entire dose of nitrogen was applied through urea as basal in pigeonpea where as in finger millet 50% N as basal and remaining 50% after 30 days after sowing; in 100% N through organic sources, 50% of N through FYM and 50% of N through *Glyricidia* was supplied to the crop by incorporating to the field 20 days before sowing of crop; in 100% N through integrated supply, 50% N through urea, remaining nitrogen was supplied through farm yard manure and *Glyricidia* in equal proportion to meet the remaining nitrogen based on their nitrogen equivalent before 20 days of sowing. Recommended phosphorus and potassium was supplied through single super phosphate and muraite of potash, respectively to all the treatements as basal.

In each treatment, a quadrat of 0.5 x 0.5 m was selected at random for recording weed count. Accordingly, the number of monocots, dicots and sedges present within quadrant were counted and expressed as no./m^2. Later the original values were subjected to suitable transformations (square root or logarithmic) depending on the variation in the data and subjected to statistical analysis.

For live weed seedbank analysis, soil samples were collected two times, before sowing of pigeonpea in May 2010 and after harvest of fingermillet in November 2011 to determine the live weed seedbank composition. Samples were taken from three soil depths (0-10, 10-20 and 20-30 cm) in the field. From each plot, five samples of soils with a core auger were taken at randomly. Soil samples from each plot were pooled within the same depth. Soil samples from each plot were thoroughly mixed air dried under shade and ground gently with hands in to the small pieces. Thereafter, 1 kg each of soil, devoid of large rocks and root fragments, was transferred into 20 x 35 cm plastic trays and with 2 cm soil thickness, placed in light screen house. These were watered as and when needed to maintain adequate moisture. Weed seedlings emerged were identified, counted and removed. Seedlings of unidentified weeds were transplanted in to other pots and grown until their identities could be verified. After this, the soil was thoroughly mixed watering was continued for next flush of weed seed germination. The cycle of operation was repeated after every flush of germination, identification and removal of seedlings. Watering was continued for three weeks after weed seed germination ceased.

The data were subjected to statistical analysis to determine differences among tillage, nutrient management practices and different soil depths.

RESULTS AND DISCUSSION

The dominant weed species observed both in experimental field and weed seedbank studies were *Borreria articularis*, *Cynodon dactylon* and *Cyperus rotundus.*

Effect of tillage on weeds and weed seedbank

Different tillage practices significantly influenced weed population. Irrespective of the weed species, conventional tillage significantly reduced the population of weeds compared to reduced tillage and minimum tillage. The inversion of soil by following conventional tillage resulted in deeper placement of weed seeds which could not emerge out, causing a significant reduction in the population of weeds. Similar result was observed by Chahal *et al.* (2003). In minimum tillage during both the years, dominance of perennial grass and sedge started to increase. In minimum tillage due to less disturbance and falling of weed seeds on to the surface of soil both weed population and weed dry weight was significantly higher compared to reduced and conventional tillage treatments (Table 2). Satisfactory weed control in conventional tillage treatment may be attributed to better weed control in this tillage practice and to the stimulatory effect of tillage in inducing weed seed germination and it might be due to the greater deposition of weed seed at soil surface and ploughing each time might kill the germinated weeds. This had a general agreement with previous studies of Ball and Miller (1990), Amanuel and Tanner (1991) and Mohler (1993).

In conventional tillage, weed seeds were distributed uniformly among different soil depths compared to minimum tillage and reduced tillage (Table 3). In minimum tillage all three types of weed species, *viz*. broad-leaved, grass and sedges were significantly higher than other two tillage practices and most of the weed seeds were concentrated in top layers of soil.

Table 1. Effect of tillage and nitrogen management practices on growth and yield of fingermillet

Treatment	Plant height at harvest (cm)	Number of tillers/plant	Grain weight/ plant (g)	Grain yield (t/ha)	B:C ratio
Tillage					
T_1: 3 ploughings + 3 inter cultivations	79.2	6.16	12.0	3.03	3.57
T_2: 2 ploughings + 2 inter cultivations	70.3	5.37	10.7	2.26	2.83
T_3: 1 ploughing + 1 inter cultivation	61.2	4.47	8.3	1.11	1.56
LSD (P=0.05)	2.81	0.61	1.2	0.49	
Nitrogen management					
N_1: 50% N through FYM+ 50 % N through *Glyricidia*	66.2	4.91	9.9	1.66	1.71
N_2: 25% N through FYM+ 25 % N through *Glyricidia* + 50% N through Urea	74.4	5.77	10.7	2.67	3.23
N_3: 100% N through Urea	70.0	5.33	10.4	2.07	3.02
LSD (P=0.05)	3.60	0.40	0.31	0.25	

Table 2. Effect of tillage and nitrogen management practices on weed density (no./m^2) and weed dry weight (g/0.25 m^2) in fingermillet at harvest

Treatment	Monocots (+)	Dicots (+)	Sedges (+)	Total weed density (#)	Total weed dry weight (#)
Tillage					
T_1: 3 ploughings + 3 inter cultivations	3.52 (11)	2.76 (6.7)	2.81 (7.0)	1.43 (25)	1.26 (17)
T_2: 2 ploughings + 2 inter cultivations	4.94 (23)	3.83 (13.7)	4.22 (16.9)	1.75 (54)	1.69 (47)
T_3: 1 ploughing + 1 inter cultivation	5.78 (33)	4.70 (21.1)	4.96 (23.8)	1.89 (77)	1.80 (62)
SEm±	0.15	0.10	0.12	0.01	0.03
LSD (P=0.05)	0.59	0.41	0.37	0.08	0.10
Nitrogen management					
N_1: 50% N through FYM+ 50 % N through glyricidia	4.84 (23)	3.81 (14.3)	4.10 (16.6)	1.71 (54)	1.61 (44)
N_2: 25% N through FYM+ 25 % N through glyricidia + 50% N through Urea	4.76 (23)	3.77 (13.9)	4.0 (15.9)	1.69 (52)	1.59 (42)
N_3: 100% N through Urea	4.64 (22)	3.71 (13.3)	3.90 (15.1)	1.67 (50)	1.56 (39)
SEm±	0.10	0.04	0.09	0.01	0.02
LSD (P=0.05)	NS	NS	NS	NS	NS

*Figures in parentheses indicate original values, NS- Non significant, Data subjected to, + - square root $(\sqrt{x+1})$, # - log $(\sqrt{x+2})$ transformations

Effect on yield

Plant height was significantly higher under conventional tillage (79.2 cm) than reduced tillage (70.3 cm) and minimum tillage (61.2 cm). Similarly conventional tillage produced significantly higher tiller number (6.16/plant), grain weight (12 g/plant) and grain yield (3.03 t/ha) compared to other tillage practices (Table 1). This may be due to creation of favourable physical condition for seed germination, seedling emergence, stand establishment and subsequent growth which contributed for better growth, yield attributes and yield.

Soil depth and tillage interactions

The interaction between soil depth and tillage was significant. All the dominant weed species observed, *viz. Borreria articularis*, *Cyperus rotundus* and *Cynodon dactylon* were significantly reduced by conventional tillage (Table 2 and 3). The live weed seedbank distribution differed between tillage practices. In minimum tillage practices, large number of live weed seeds was found at the depth of 0-10 cm followed by reduced tillage and conventional tillage. This may be attributed to greater deposition of weed seed at the soil surface due to less disturbance to weeds in minimum tillage which resulted in more addition of weed seeds at the end of their life cycle. In conventional tillage, live weed seeds were distributed more or less uniform compared to reduced and minimum tillage. The total live weed seedbank was higher in minimum tillage and lowest live weed seed bank was observed in conventional tillage (Table 3). This may be attributed satisfactory control of weeds by intensive tillage practices. Similar findings were reported by Ball and Miller (1990).

Table 3. Total live weed seedbank (number per kg of soil) as influenced by tillage, Soil depth and nitrogen management practices

Treatment	At 15 days	At 30 days	At 45 days	At 60 days
Tillage (T)				
T_1	1.16 (13.0)	1.27 (18.3)	0.99 (8.9)	0.69 (3.9)
T_2	1.56 (36.2)	1.66 (49.9)	1.48 (34.7)	1.06 (11.7)
T_3	1.63 (44.8)	1.81 (66.8)	1.64 (46.2)	1.26 (19.7)
SEm±	0.02	0.02	0.02	0.03
LSD (P=0.05)	0.07	0.06	0.07	0.08
Nitrogen (N)				
N_1	1.48 (34.7)	1.60 (45.1)	1.41 (30.2)	1.04 (10.5)
N_2	1.45 (33.0)	1.58 (43.3)	1.37 (28.3)	1.01 (11.3)
N_3	1.42 (31.4)	1.55 (41.5)	1.35 (26.6)	0.97 (9.9)
SEm±	0.02	0.02	0.02	0.03
LSD (P=0.05)	NS	NS	NS	NS
Soil depth (D)				
D_1-10 cm	1.65 (53.2)	1.74 (60.5)	1.56 (40.8)	1.26 (20.3)
D_2- 20 cm	1.44 (28.1)	1.59 (41.7)	1.38 (27.9)	1.01 (10.0)
D_3- 30 cm	1.26 (17.9)	1.40 (27.3)	1.19 (16.5)	0.75 (5.0)
SEm±	0.02	0.02	0.02	0.03
LSD (P=0.05)	0.07	0.06	0.07	0.08

T_1- 3 ploughings + 3 Inter cultivations, T_2- 2 ploughings + 2 Inter cultivations, T_3- 1 ploughing + 1 Inter cultivation, N_1- 50% N through FYM and 50% N through Glyricidia, N_2-25% N through FYM, 25% N through Glyricidia and 50% N through Urea, N_3-100 % N through Urea, NS - Non significant, *Figures in parentheses indicate original values, Data subjected to log $(\sqrt{x+2})$ transformation

Effect of nitrogen management on weed seed-bank and yield

Nitrogen management practices didn't influence weeds and live weed seed bank significantly. However, nitrogen management practices significantly influenced on growth and yield of fingermillet. Grain yield of fingermillet in 100% N supplied through urea was 2.07 t/ha, which increased to 2.67 t/ha due to 50% substitution of N with farm yard manure and Glyricidia leaf manure (Table 1). This has accounted for 28.97% increase in grain yield over 100% N supply through urea. Further, increasing the level of substitution of N by 100% with organics (FYM and *Glyricidia*) did not influence the grain yield rather resulted in significant reduction in yield. Combined application of both the source of nitrogen has resulted in better availability of nitrogen throughout the crop growth period. Fertilizer source of N has met the nutrient requirement of the plant in the early growth stages and the mineralized nitrogen from FYM and *Glyricidia* could supply the nutrient in the later growth stages of the crop. Hence, there was continuous supply of nutrients throughout the crop growth period. Whereas, in 100% N substitution by farm yard manure and *Glyricidia*, mineralization occurs slowly and the supply of nitrogen in the early stages of crop growth was delayed and thus the crop was starved of nitrogen, which has affected crop growth and yield. Similar results were obtained by Aruna and Mohammad (2006), Dass and Patnaik (2007) and Kumar *et al.* (2007).

Tillage and soil depth had significant effects on weeds and live weed seedbank. Live weed seedbank size was greater in minimum tillage than conventional tillage or reduced tillage. This resulted in better performance of fingermillet crop in Southern India.

Table 4. Total live weed seed bank (number per kg of soil) as influenced by tillage at different soil depths

Treatment	At 15 days	At 30 days	At 45 days	At 60 days
T_1D_1	1.26 (17)	1.46(28)	1.21(15)	0.95(7.3)
T_1D_2	1.19 (12)	1.29(18)	0.97(7.3)	0.74(4.0)
T_1D_3	1.03(9.0)	1.04(9.2)	0.81(4.6)	0.38(0.5)
T_2D_1	1.71 (50)	1.77(58)	1.63(41)	1.25(18)
T_2D_2	1.55 (34)	1.67(45)	1.46(27)	1.11(13)
T_2D_3	1.43 (25)	1.53(32)	1.36(22)	0.82(4.9)
T_3D_1	1.98 (93)	1.99(96)	1.83(66)	1.57(36)
T_3D_2	1.57 (37)	1.80(62)	1.70(49)	1.17(14)
T_3D_3	1.33 (19)	1.64(42)	1.39(23)	1.05(9.6)
LSD (P=0.05)	0.09	0.07	0.09	0.14

T_1-3ploughings + 3 Inter cultivations, T_2-2 ploughings + 2 Inter cultivations, T_3- 1 ploughing +1 Inter cultivation, D_1- 10 cm depth, D_2- 20 cm depth, D_3- 30 cm depth, *Figures in parenthesis indicate original values, Data subjected to log $(\sqrt{x+2})$ transformation

Among nitrogen management practices, integrated supply of N found promising in getting better yield of fingermillet however there was no effect of nutrient management practices on weeds and live weed seed bank.

I was concluded that tillage is the limiting factor for live weed seed bank size in the soil. This suggested that intensive tillage practices could make considerable reduction in live weed seedbank in the soil. However, further research will be required to confirm these initial findings and to determine whether dynamics of individual species follows the same pattern as total weed density and which can be made use for more accurate future predictions related to the population dynamics of the weed seed in the soil.

REFERENCES

Amanuel G and Tanner DG. 1991. The effect of crop rotation in two wheat crop production zones of southern Ethiopia. *Weed Science* **39**: 205-209.

Aruna E and mohammad S. 2006. Nutrient management options in rice-sunflower cropping system to sustain productivity and conserve the soil fertility. *International Journal of Agricultural Sciences* **2**(1): 122-129.

Ball DA and Miller SD. 1990. Weed seed population response to tillage and herbicide use in three irrigated cropping sequences. *Weed Science* **38**: 511-517.

Buhler DD. 1991. Influence of tillage systems on weed population dynamics and control in the Northern corn belt of the United States. *Advances in Agronomy* **1**: 51-60.

Chahal PS, Brar HS and Walia US. 2003. Management of *Phalaris minor* in wheat through integrated approach. *Indian Journal of Agronomy* **35**(1&2): 1-5.

Dass A and Patnaik US. 2007. On-farm evaluation of integrated nutrient management in ragi (*Eleusine coracana*). *Indian Journal of Soil Conservation* **35**(1): 79-81.

Dogra P, Joshi BP and Sharma NK. 2002. Economic analysis of tillage practices for maize cultivation in the Himalayan humid subtropics. *Indian Journal of Soil Conservation* **30**(2): 172-178.

Kumar O, Basavarajnaik T and Palaiah P. 2007. Effect of weed management practices and fertility levels on growth and yield parameters in fingermillet. *Karnataka Journal of Agricultural Sciences* **20**(2): 230-233.

Mohler CL. 1993. A model of the effect of tillage on emergence of weed seedlings. *Ecological Applications* **3**: 53-73.

Yenish JP, Doll JD and Buhler DD. 1992. Effect of tillage on vertical distribution and viability of weed seeds in soil. *Weed Science* **40**: 429-433.