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Wheat residue incorporation and weed management effect on weed seedbank and groundnut yield

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ABSTRACT

The experiment was laid out in split plot design with three replications. The main plots comprised three residue management treatments and sub-plots comprised seven weed management treatments. Results revealed that significantly, highest pod yield (1.47 t/ha) with maximum net returns was recorded under the wheat residue incorporation (IC) *fb* soil solarization. Among the weed management, significantly highest pod yield (1.68 t/ha) and haulm yield (3.35 t/ha) was recorded under weed free and unweeded check registered significantly lowest pod yield (0.72 t/ha). Significantly lower number of total weeds at 30, 60 DAS and at harvest, dry weight of weeds and weed seedbank, lowest weed index and higher weed control index was recorded under the wheat residue incorporation *fb* soil solarization and weed free. Among the weed management, next superior treatments were pendimethalin *fb* imazamox + imazethapyr, pendimethalin *fb* IC and HW and suicidal germination *fb* tillage *fb* IC and HW in the both year of 2014 and 2015.

Key words: *Arachis hypogaea*, Economics, Residue management, Weed indices, Weed management, Weed seed-bank

Groundnut is highly susceptible to weed infestation because of its slow growth in the initial stages up to 40 days, short stature and underground pod bearing habit. Season long weed competition reduces the yield as high as 24 to 70% (Wani *et al.* 2010). The main limiting production factor of groundnut is poor cultural and weed management practices. Therefore, it is essential to keep groundnut fields weed free at the critical stages of crop-weed competition which was found to be the first four to eight weeks after sowing (Jat *et al.* 2011).

The weed seedbank is an important part of crop-weed ecology as it is the most important source of annual weeds in cropping systems and effects efficiency of weed management. This study aims to acquire the information on weed seedbank dynamics and its integrated management by incorporating cultural, physical and chemical methods. Wheat (*Rabi*)-fallow (summer)-groundnut (*Kharif*) is the pre-dominant crop sequence in the Saurashtra region of Gujarat. Owing to labour shortage and its high cost, harvesting of wheat is mostly carried out by combine harvester, which left large quantities of wheat residue. Now their usefulness has been considered as an important resource that can bring significant physical, chemical, biological changes into the soil and suppresses weeds and prevent weed seeds to recycle in soil (Sharma 2014).

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MATERIALS AND METHODS

An experiment was conducted at Weed Control Research Scheme, Department of Agronomy, Junagadh Agricultural University, Junagadh (Gujarat) during *Kharif* (rainy) seasons of 2014 and 2015. The soil of the experimental plot was clayey in texture and slightly alkaline in reaction (pH 8.1 and EC 0.43 dS/m), medium in organic carbon (0.57 and 0.60%), low in available N (249.30 and 241.00 kg/ha), medium in available P_2O_5 (39.48 and 35.89 kg/ha) and medium in available K_2O (274.60 and 279.00 kg/ha) in 2014 and 2015, respectively. The experiment was laid out in split plot design with three replications. The main plots comprised of residue management treatments, *viz.* (i) burning of wheat residues, (ii) wheat residue incorporation by rotavator *fb* soil solarization with 25 µm polythene sheet for 15 days and (iii) wheat residue incorporation by rotavator *fb* application of *Trichoderma viride* 5 kg/ha + 20 kg N/ha and sub-plots contained weed management treatments, *viz.* (i) stale seedbed (pre-sowing irrigation *fb* killing the weed flush by subsequent tillage) *fb* IC and HW at 45 DAS, (ii) suicidal germination (application of ethylene 2000 ppm + KNO_3 2000 ppm with pre-sowing irrigation) *fb* killing the weed flush by subsequent tillage) *fb* IC and HW at 45 DAS, (iii) pendimethalin 900 g/ha as Pre-emergence (PE) *fb* IC and HW at 45 DAS, (iv) HW and IC at 15 DAS *fb* pre-mix imazamox + imazethapyr 70 g/ha as POE at 25 DAS, (v) pendimethalin 900 g/ha as PRE *fb* pre-mix

imazamox + imazethapyr 70 g/ha as POE at 25 DAS, (vi) weed free-three IC + five HW and (vii) unweeded check. The groundnut (cv. *Gujarat Groundnut-20*) was sown at 60 x 10 cm spacing using seed rate of 120 kg/ha by bullock drawn seed driller on 24th and 8th June during 2014 and 2015, respectively. The crop was fertilized with 12.5, 25 and 50 kg N P_2O_5 K_2O/ ha, respectively. Herbicides were sprayed as per treatments using knapsack sprayer fitted with flat fan nozzle using spray volume of 500 l/ha water. Data on species wise weed count, dry weight of weeds and number of weed seeds in soil per core sample was recorded as per the FAO protocol. The experimental data recorded for growth parameters, yield attributes and yield parameters were statistically analyzed for level of significance.

RESULTS AND DISCUSSION

Weed flora and weed seedbank

The weed species observed during both the years of experiment and their % dominance have been given (Table 1). Significantly lowest numbers of total weeds at 30, 60 DAS and at harvest, dry weight of weeds and weed seedbank, lowest weed index and higher weed control index was recorded under wheat residue incorporation (IC) *fb* soil solarization and weed free-three IC + five HW (Table 2 and 3). Among the weed management next superior treatments were pendimethalin *fb* imazamox + imazethapyr, pendimethalin *fb* IC and HW and suicidal germination *fb* tillage *fb* IC and HW. Soil solarization might have destroyed weed seeds and propagules present in the upper soil, but not so effective against sedge propagules existed deeper in soil, hence there would be less population of weeds than other treatments, while *Trichoderma viride* might have decomposed weed seeds and propagules which reflected in less number of weeds and ultimately lower weed biomass under both these treatments. These findings were in conformity with those reported by Branko *et al*. (2011).

Table 1. Weed species and per cent dominance

Weed species		% dominance in experimental site	
		2014	2015
Monocots	*Echinochloa colona*	23.65	53.76
	Eluropus villosus	14.86	1.55
	Indigofera glandulosa	6.53	5.80
	Brachiaria ramosa	2.03	-
	Dactyloctenium aegyptium	-	3.68
	Ammannia baccifera	18.02	-
Dicots	*Leucas aspera*	5.40	1.47
	Digera arvensis	2.70	5.40
	Commelina benghalensis	2.03	2.61
	Eclipta alba	2.03	5.72
	Portulaca oleracea	1.58	0.98
	Commelina nudiflora	0.68	0.57
	Phyllanthus niruri	0.45	1.88
	Euphorbia hirta	-	1.14
	Parthenium hysterophorus	-	0.65
	Tridax procumbens	-	0.57
Sedge	*Cyperus rotundus*	20.04	14.22

Yield attributes, yields and economics

Significantly, highest pod yield (1.47 t/ha) with maximum net returns was recorded under the wheat residue incorporation *fb* soil solarization with increased magnitude of 14.2% over the burning of residues among the different residue management treatments (Table 2). Among the weed management, significantly highest pod yield (1.68 t/ha) and haulm yield (3.35 t/ha) was recorded under weed free, which was statistically at par with pendimethalin *fb* imazethapyr + imazamox and pendimethalin *fb* IC and HW with increased magnitude of 124.9 and 124.5%. Conversely, the unweeded check registered significantly lowest pod yield (0.72 t/ha). The higher yield under these treatments could be ascribed to lower dry weight of weeds. Burning of residues and unweeded check recorded lowest pod and haulm yields owing to severe crop-weed competition for resources. These findings were in agreement with earlier reports (Dubey *et al.* 2010, Kalhapure *et al.* 2014. Among the weed management, maximum net returns and B:C ratio were achieved with pendimethalin *fb* IC and HW closely followed by weed free, pendimethalin *fb* pre-mix imazethapyr + imazamox and suicidal germination *fb* tillage *fb* IC and HW (Table 2). This might be due to effective and efficient control of weeds by integration of hand weeding and pre-emergence and post-emergence herbicides. The higher benefits obtained under these treatments were also due to comparatively less cost of herbicides than manual weeding as well as higher pod and haulm yields of groundnut. These findings was in vicinity with those reported by Vaghasia and Nadiyadhara (2013).

It was concluded that effective management of wheat residues, weeds and weed seedbank along with profitable cultivation of groundnut in *Kharif* season can be achieved by incorporation of wheat residues in soil by rotavator followed by soil solarization with 25 µm polythene sheet for 15 days during hot summer or application *Trichoderma viride* 5 kg/ha + 20 kg N/ha and pre-emergence application of pendimethalin 900 g/ha supplemented with either IC and HW at 45 DAS or pre-mix imazamox + imazethapyr 70 g/ha as post-emergence at 25 DAS.

Table 2. Effect of residue and weed management on weed counts, weed dry weight and weed seedbank in groundnut

Treatment	Total weed count per m^2 at						Dry weight of weeds (kg/ha)		Number of weed seeds/core	
	2014			2015						
	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest	2014	2015	2014	2015
Residues management(Main Plot)									215 (Initial)	181 (Initial)
Burning of wheat residues	3.72(15.9)	3.42(14.1)	4.33(21.1)	5.72(41.7)	4.81(32.1)	5.78(43.2)	1142	1419	259	242
Wheat residue incorporation *fb* soil solarization with 25 µm polythene sheet for 15 days	2.82(9.4)	3.21(10.9)	3.42(12.9)	4.20(20.9)	3.92(18.3)	4.73(25.8)	687	951	161	171
Wheat residue incorporation *fb T. viride* + N	3.28(12.7)	3.33(13.1)	4.12(18.5)	5.32(37.5)	5.01(33.4)	5.70(40.5)	813	1229	234	245
LSD(P=0.05)	0.55	NS	0.36	0.49	0.47	0.58	151	200	45	51
Weed management(Sub plot)										
Stale seedbed *fb* IC and HW	4.43(19.4)	3.37(11.1)	4.15(16.9)	6.80(46.6)	3.22(10.1)	4.37(19.1)	979	1272	168	170
Suicidal germination *fb* tillage *fb* IC and HW (Before sowing the crop)	4.85(23.4)	3.34(10.9)	4.11(16.7)	6.73(45.8)	4.01(15.9)	4.78(22.7)	788	870	99	95
Pendimethalin *fb* IC and HW	2.34(5.2)	3.15(9.7)	3.63(13.0)	5.02(25.3)	3.61(12.8)	4.37(19.1)	521	553	86	78
HW and IC *fb* imazethapyr + imazamox	2.24(4.9)	2.88(7.9)	3.53(12.2)	2.23(4.8)	4.47(20.2)	5.34(28.2)	770	1188	191	180
Pendimethalin *fb* imazethapyr + imazamox	2.49(6.2)	3.09(9.6)	3.33(10.9)	4.48(20.2)	4.19(17.2)	4.93(24.2)	489	628	89	80
Weed free	1.35(1.6)	1.19(1.0)	1.95(3.6)	0.96(0.6)	1.96(3.7)	2.50(6.1)	40	58	68	58
Unweeded check	5.23(27.8)	6.23(39.0)	6.99(49.3)	9.33(90.4)	10.60(115)	11.52(136)	2577	3825	824	876
LSD(P=0.05)	0.50	0.33	0.40	0.53	0.41	0.58	128	159	50	56

$\sqrt{x+0.5}$ transformation (figures in parentheses are original values)

Table 3. Weed indices, yields and economics of groundnut under residue and weed management

Treatment	Weed index (%)		Weed control efficiency (%)		Pod yield (t/ha)	Haulm yield (t/ha)	Gross returns (x10^3 `/ha)	Cost of cultivation (x10^3 `/ha)	Net returns (x10^3 `/ha)	BCR
	2014	2015	2014	2015						
Residues management (main plot)										
Burning of wheat residues	21.85	18.76	64.71	68.03	1.28	3.11	71.59	28.44	43.15	2.49
Wheat residue incorporation *fb* soil solarization with 25 µm polythene sheet for 15 days	17.71	17.15	67.36	69.26	1.47	2.86	78.77	34.38	44.39	2.27
Wheat residue incorporation *fb T. viride* + N	17.85	17.77	65.66	68.74	1.36	3.13	7506	31.51	43.55	2.36
LSD (P=0.05)	-	-	-	-	0.07	NS	-	-	-	-
Weed management (sub plot)										
Stale seedbed *fb* IC and HW	38.07	32.72	62.38	66.90	1.08	2.8	61.64	30.37	31.27	2.03
Suicidal germination *fb* tillage *fb* IC and HW (Before sowing the crop)	6.62	4.35	68.97	77.21	1.59	3.14	85.51	32.85	52.66	2.61
Pendimethalin *fb* IC and HW	4.65	1.91	79.94	85.49	1.62	3.22	87.50	31.15	56.35	2.82
HW and IC *fb* imazethapyr + imazamox	25.18	24.26	70.56	68.98	1.26	3.16	70.93	31.47	39.46	2.26
Pendimethalin *fb* imazethapyr + imazamox	4.35	2.70	81.04	83.67	1.62	3.27	87.60	32.09	55.50	2.74
Weed free	0.00	0.00	98.49	98.48	1.68	3.35	90.73	34.76	55.96	2.62
Unweeded check	55.10	59.32	0.00	0.00	0.72	2.21	42.09	27.42	14.67	1.54
LSD (P=0.05)	-	-	-	-	0.08	0.29	-	-	-	-

Groundnut yields and economics are pooled of two years

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