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Bio-efficacy of Herbicides on Nutrient Uptake, Yield and Economics of Groundnut

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Abstract

Field experiment was conducted during July to October, *kharif*, 2013 on red sandy loam soil to find out efficient method of weed control in groundnut at College of Agriculture, Raichur, Karnataka, India. Results indicated that, pod yield obtained with pre and post emergent herbicides along with intercultivation at 35 Days After Sowing (DAS) were comparable with interculture at 15, 30 and 40 days after sowing+one hand weeding at 25 days after sowing and pendimethalin 38.7 CS @ 1000 g a.i. ha^{-1}+2 IC at 25 and 35 DAS. Weed control efficiency of 61.55% was achieved in integrated method compared to 22.94% with herbicides application alone at harvest. Among the herbicides application of pendimethalin at 1000 g a.i. ha^{-1} fb imazethapyr at 75 g a.i. ha^{-1} was found superior in terms of pod yield, haulm yield and weed control efficiency. From the studies it can be concluded that significantly higher net returns (₹ 99,518 ha^{-1}) was recorded in weed free check followed by pendimethalin 38.7 CS 1000 g *a.i.* ha^{-1} fb imazethapyr 10 SL @ 75 g a.i. ha^{-1} fb IC at 35 DAS. On the other hand significantly lower net returns of (₹ 17,768 ha^{-1}) were registered with weedy check compared to rest of the treatments. The highest B:C (3.52) was obtained from weed free check.

Keywords: Groundnut, Weeds, Pendimethalin, pre-emergent, bio-efficacy, nutrient uptake

1. Introduction

Groundnut (*Arachis hypogaea* L.) is one of the most important oilseeds crops in India. Groundnut contributes more than 50% edible oil production of the country and plays a vital role in oilseed production (Vaghasia and Nadiyadhara, 2013). It is one of the most important food and cash crop of our country. Groundnut is also called as wonder nut and poor men's cashew nut. Weeds are notorious, causing several health disorders, environmental pollution, decreasing the aesthetic value of land, obstacle in aquatic life, mining-off huge quantity of water and nutrients from the soil, crop yield reducers that are, in many situations, economically more important than insects, fungi or other pest organisms (Verma et al., 2008; Gupta et al., 2013). Groundnut crop is highly susceptible to weed infestation because of its slow growth in its initial stages up to 40 days (Sathya Priya et al., 2013) due to short plant height and underground pod bearing habit. Weed infestation is considered as one of the critical factor for winter season groundnut production (Srinivasa Rao et al., 2011). Peanut has a prostate growth habit, a relatively shallow canopy and is slow to shade interrows allowing weeds to be more competitive. One of the major factors responsible for low productivity of groundnut is weed infestation. As groundnut is grown mainly in the rainy season when the condition is more favourable for weed growth which encourages repeated flushes of grasses and broad leaved weeds during the entire season for competition with the crop, specially during early stages of crop growth (Jadhav et al., 2015). Weed menace is a major constraint in groundnut production and it aggravate after seed emergence. Among various weed management practices chemical method has become cost effective and timely control of weeds (Verma et al., 2015). Weeds not only compete with this crop for the resources but also interfere with pegging, pod development and harvesting of it (Kar et al., 2015). Season long weed competition reduces the yield as high as 24 to 70% (Wani et al., 2010). The first three to four weeks of crop growth period are critical for weed control in groundnut (Mulik et al., 2010). It is a unique crop, combining the attributes of both oilseed and legume crop in the farming system of Indian agriculture. Groundnut weeds comprise diverse plant species from grasses to broad leaf weeds and sedges, and cause substantial yield loses (15 to 75%) which is more in rainfed spanish bunch type than in virginia type groundnut. Weeds also affect groundnut through the production of harmful allelo-chemicals. Thus, weed control is the foremost critical production factor in groundnut cultivation. Mechanical method of weed control is a common practice followed in groundnut. However, this method is time consuming, expensive and tedious and practically not feasible where the labour is scarce and costly. Hence, the use of herbicides in combination with other mechanical weed control

practices help the crop for extended weed free condition.

2. Materials and Methods

The field experiment entitled "Bio-efficacy of herbicides on nutrient uptake, Yield and Economics of Groundnut" was conducted during July to October, *kharif,* 2013 at College of Agriculture. Raichur, The soil of the experimental site was red having sandy loam in texture with low in available nitrogen (212 kg ha^{-1}), medium in available phosphorus (30 kg ha^{-1}) and potassium (328 kg ha^{-1}). The experiment was laid out in Randomized Block Design (RBD) with ten treatments replicated thrice. The gross and net plot was 5.4×4.5 m^2 and 4.2×4.1 m^2 respectively. Sowing of groundnut was done by dibbling two kernels of variety R-2001-2 at 30×10 cm^2 spacing. All the recommended management practices were followed. Pre-emergence application of pendimethalin was done day after sowing and post-emergence application Quizalofop-p-ethyl and Imazethapyr herbicides were applied at 25 DAS. Nitrogen, phosphorus and potassium contents in composite plant samples of groundnut at harvest was estimated by modified micro-kjeldhal method, Vanadomolybdate yellow colour method and flame photometer method, respectively as outlined by Jackson (1967). Soil samples were collected from each treatment at 10 days after herbicide spray (pre and post-emergent herbicides) and soil microbial population (bacteria, fungi and actinomycetes) in the soil per sample was carried out by following standard dilution plate count technique. The petri plates were incubated at 30 °C for 3 to 6 days and population were counted and expessed as cfu g^{-1} of soil (Alef and Nannipieri, 1995). The treatment details are Pendimethalin (38.7% CS) @ 1000 g a.i. ha^{-1} fb 2 intercultivation at 25 and 35 DAS, Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} at 20 to 25 DAS, Quizalofop-ethyl (5% EC) @ 45 g a.i. ha^{-1} at 20 to 25 DAS, Imazethapyr (10% SL) @ 75 g a.i. ha^{-1}+Quizalofop-ethyl (5% EC) @ 45 g a.i. ha^{-1} at 20–25 DAS, Pendimethalin (38.7% CS) @ 1000 g a.i. ha^{-1} fb Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} at 20 to 25 DAS, Pendimethalin (38.7% CS) @ 1000 g *a.i.* ha^{-1} fb Quizalofop–ethyl (5% EC) @ 45 g a.i. ha^{-1} at 20 to 25 DAS, Pendimethalin (38.7% CS) @ 1000 g a.i. ha^{-1} fb Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} fb 1 intercultivation at 35 DAS, Pendimethalin (38.7% CS) @ 1000 g a.i. ha^{-1} fb Quizalofop-ethyl (5% EC) @ 45 g a.i. ha^{-1} at 20-25 DAS fb 1 intercultivation at 35 DAS, Weed free check (interculture at 15, 30 and 40 DAS) + 1 Hand weeding at 25 DAS and Weedy check.

3. Results and Discussion

The major monocot weeds noticed in the experimental site were *Cynadon dactylon (L.), Panicum spp., Dactyloctenium aegyptium, Digitaria marginata* and *Erogrostis gangetica* and dicot weeds were *Phyllanthus niruri, Tribulus terrestris, Abutilon indium, Euphorbia hirta, Trichodesma spp., Portuluca oleracaea L., Lagasca mollis, Tridax procumbens, Amaranthus viridis, Parthenium hysterophorus, Mimosa pudica, Digeria arvensis, Leucus aspera* and the common sedge was *Cyperus rotundus* were observed. The least total weed density (8.39 m^{-2}) at harvest was observed in pendimethalin 38.7% CS @ 1000 g a.i. ha^{-1} fb imazethapyr 10% SL @ 75 g a.i. ha^{-1} plus IC at 35 DAS compared to weedy check (19.48 m^{-2}). This may be attributed to effective control of weeds during early stages of crop growth by pre-emergent herbicides and at later stages by application of post-emergent herbicides with intercultivation at 35 DAS. These results are in line with the findings of Kalpana and Velayuthum (2004) and herbicides are often considered as quick and easy solution for controlling weeds in agriculture (Anil et al., 2011). At harvest, there was an increase in weed dry weight in all the treatments because of the continuous emergence of weeds during this period. Similar results were reported by Kumar (2009). The maximum weed control efficiency was recorded by pendimethalin 38.7 CS @ 1000 g a.i. ha^{-1} fb imazethapyr 10 SL fb IC at 35 DAS (61.55%) and was on par with pendimethalin 38.7 CS fb 2 IC at 25 and 35 DAS (52.88%) and pendimethalin 38.7 CS @ 1000 g a.i. ha^{-1} fb quizalofop-ethyl 5 EC @ 45 g a.i. ha^{-1} fb IC at 35 DAS (40.93%). This might be due to combination of both cultural and chemical methods which was found to be more effective in suppressing the weed density as well as weed dry matter. These results are in confirmatory with (Rao et al., 2010) (Table 1). Patel et al. (1997) have reported reduced pod yield due to higher weed indices, this reduction in yield attributed to higher density of monocots, dicots and higher dry matter production of weeds under weedy check. Sasikala et al. (2006) reported that plant height and leaf area index were higher with application of pendimethalin @ 1500 g a.i. ha^{-1} as PRE herbicide fb imazethapyr @ 75 g a.i. ha^{-1} POE herbicide at 20 DAS. Weedy check recorded lower plant height at harvest (26.33 cm) which may be due to severe weed competition at these stages of crop growth. Leaf area and leaf area index was higher in weed free check at all the stages of crop growth (6.53 and 2.17 dm^2 $plant^{-1}$) followed by pendimethalin 38.7 CS @ 1000 g a.i. ha^{-1} fb imazethapyr 10 SL @ 75 g a.i. ha^{-1} fb IC at 35 DAS (5.70 and 1.90 dm^2 $plant^{-1}$) (Table 2). Persistence of the assimilatory surface area is pre-requisite for a prolonged photosynthetic activity and ultimate productivity. Leaf area being the photosynthetic surface plays a vital role in production and availability of photosynthates. Chlorophyll content at 15 and 45 days after sowing differed significantly due to weed management practices. The highest chlorophyll content at 15 and 45 DAS (5.73 and 35.33 SPAD meter values) were obtained in weed free check and was followed by pendimethalin 38.7 CS 1000 g a.i. ha^{-1} fb imazethapyr 10 SL @ 75 g a.i. ha^{-1} fb IC at 35 DAS (5.37 and 34.90 SPAD meter values) (Table 3). This might be due to lower weed competition during critical period of the crop growth stages, which might have provided better availability of soil moisture and nutrients for crop growth. The data on microbial studies indicated that weed free condition/cultural method of weed control recorded higher bacterial, fungal and actinomycetes count at 15 and 35 DAS g^{-1} of soil which was comparable

Table 1: Total weed count (m^{-2}), Dry weight of weeds (g m^{-2}), Weed control efficiency (%) and weed index (%) in groundnut as influenced by weed control treatments

Treatments	Total weed count (m^{-2})	Dry weight of weeds (g m^{-2})	WCE (%)	WI (%)
T_1	10.08 (100.67)	2.11 (127.67)	52.88	15.32
T_2	12.52 (155.67)	2.31 (204.67)	31.15	36.93
T_3	14.82 (218.67)	2.34 (218.67)	12.90	53.02
T_4	15.76 (247.33)	2.31 (204.67)	22.94	60.48
T_5	11.99 (142.67)	2.26 (180.87)	33.80	21.43
T_6	10.95 (119.00)	2.21 (160.47)	40.93	23.96
T_7	8.39 (70.33)	2.02 (105.27)	61.55	12.37
T_8	10.86 (117.00)	2.18 (149.33)	45.10	18.42
T_9	6.19 (37.33)	1.80 (68.07)	75.18	0.00
T_{10}	19.48 (379.67)	2.44 (272.40)	0.00	65.31
SEm±	0.37	0.06	5.55	7.03
CD (*p*=0.05)	1.07	0.17	16.21	20.53

T_1: Pendimethalin (38.7% EC) @ 1000 g a.i. ha^{-1} fb 2 intercultivation at 25 and 35 DAS; T_2: Imazethapyr (10% SL) @ 75 g a.i. ha^{-1} at 20–25 DAS; T_3: Quizalofop-ethyl (5% EC) @ 45 g a.i. ha^{-1} at 20–25 DAS; T_4: Imazethapyr (10% SL) @ 75 g a.i. ha^{-1}+Quizalofop-ethyl (5% EC) @ 45 g a.i. ha^{-1} at 20–25 DAS; T_5: Pendimethalin (38.7% EC) @ 1000 g a.i. ha^{-1} fbImazethapyr (10% SL) @ 75 g a.i. ha^{-1} at 20–25 DAS; T_6: Pendimethalin (38.7% EC) @ 1000 g a.i. ha^{-1} fbQuizalofop–ethyl (5% EC) @ 45 g a.i. ha^{-1} at 20–25 DAS; T_7: Pendimethalin (38.7% EC) @ 1000 g a.i. ha^{-1} fbImazethapyr (10% SL) @ 75 g a.i. ha^{-1} fb 1 inter-cultivation at 35 DAS; T_8: Pendimethalin (38.7% EC) @ 1000 g a.i. ha-1fbQuizalofop-ethyl (5% EC) @ 45 g a.i. ha^{-1} at 20–25 DAS fb 1 intercultivation at 35 DAS; T_9: Weed free check (interculture at 15, 30 and 40 Days after sowing)+1 Hand weeding at 25 Days after sowing; T_{10}: Weedy check; Original weed count (x) data were transformed into (x+1) ½ * and weed dry wt. (x) are tranfomed in to Log (x+2) Figures in parenthesis indicate original values; PE: Pre-emergent; HW: Hand weeding; EC: Emulsifiable concentrates; IC: Inter cultivation; DAS: Days after sowing; SL: Soluble liquids;

Table 2: Plant height (cm), Number of leaves $pant^{-1}$, Leaf area (dm^{-2} plant) and leaf area index $plant^{-1}$, SPAD values, pod yield (q ha^{-1}) and haulm yield (q ha^{-1}) in groundnut as influenced by weed control treatments

Treatments	Plant height (cm)	No. of leaves $plant^{-1}$	Leaf area (dm^{-2} $plant^{-1}$)	Leaf area index	SPAD meter reading		Pod yield (q ha^{-1})	Haulm yield (q ha^{-1})
					15 DAS	45 DAS		
T_1	44.60	34.67	5.47	1.82	5.07	33.63	20.99	24.14
T_2	35.73	34.00	5.00	1.67	3.80	30.03	15.23	21.26
T_3	34.10	30.67	4.27	1.42	3.57	29.07	12.07	20.44
T_4	31.93	27.33	4.07	1.35	3.47	27.13	9.74	16.87
T_5	34.73	35.67	4.90	1.62	4.63	32.23	19.48	22.87
T_6	39.20	32.67	4.90	1.63	4.30	31.50	19.06	22.63
T_7	47.07	38.00	5.70	1.90	5.37	34.90	21.81	24.96
T_8	43.40	37.33	5.13	1.71	4.53	33.17	20.30	23.59
T_9	51.73	41.67	6.53	2.17	5.73	35.33	25.05	26.33
T_{10}	26.33	22.50	3.34	1.11	3.93	17.10	8.50	14.53
SEm±	2.54	4.25	0.42	0.14	0.39	1.93	1.85	0.64
CD (*p*=0.05)	7.43	NS	1.23	0.41	1.14	5.63	5.40	1.88

to other integrated treatments. From this studies it can be concluded that significantly higher net returns (₹ 99,518 ha^{-1}) was recorded in weed free check and was followed by pendimethalin 38.7 CS 1000 g a.i. ha^{-1} fb imazethapyr 10 SL @

Table 3: Soil microbial population(Bacteria, fungi and actinomycetes) at 15 and 30 DAS in groundnut as influenced by weed control treatments

Treat-ments	15 DAS			35 DAS		
	B	F	A	B	F	A
T_1	47.33	21.67	44.00	51.33	24.63	55.30
T_2	62.33	38.00	58.67	40.93	16.05	35.75
T_3	65.00	34.33	62.67	42.74	15.52	33.00
T_4	63.00	38.33	50.00	44.46	17.73	34.70
T_5	44.33	21.67	38.33	46.73	21.03	31.00
T_6	40.33	22.67	46.33	47.84	22.43	32.00
T_7	42.00	22.33	48.00	43.30	21.43	33.70
T_8	46.33	23.67	44.67	41.30	19.71	31.30
T_9	70.67	43.67	70.67	65.56	31.67	64.30
T_{10}	63.33	34.33	54.67	29.00	14.33	30.30
SEm±	1.75	2.16	3.41	4.94	2.62	1.67
CD (*p*=0.05)	5.12	6.29	9.95	14.42	7.65	4.89

B: Bacteria (cfu×10^7 g^{-1}); F: Fungi (cfu×10^4 g^{-1}); A: Actinomycetes (cfu×10^3 g^{-1})

75 g a.i. ha^{-1} fb IC at 35 DAS (₹ 84,274 ha^{-1}) and pendimethalin 38.7 CS @ 1000 g a.i. ha^{-1} fb IC at 25 and 35 DAS (₹ 80,830 ha^{-1}) (Table 4). On the other hand significantly lower net returns of (₹ 17,768 ha^{-1}) were registered in weedy check compared to rest of the treatments. Kori et al. (2000) reported that weed free check recorded the highest net income which may be due to efficient control of weeds resulting in higher pod yield in groundnut. The highest B:C ratio (3.52) was obtained from weed free check and was followed by pendimethalin 38.7 CS 1000 g a.i. ha^{-1} fb imazethapyr 10 SL @ 75 g a.i. ha^{-1} fb IC at 35 DAS (3.17) and pendimethalin 38.7 CS @ 1000 g a.i. ha^{-1} fb IC at 25 and 35 DAS (3.14). The lowest BC ratio (1.51) was obtained with weedy check over all other treatments. The results are confirmatory with Sardana et al. (2006).

Table 4: Economics of groundnut as influenced by weed control treatments

Treatments	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C ratio
T_1	37750	118580	80830	3.14
T_2	36444	89780	53336	2.46
T_3	35865	74737	38872	2.08
T_4	37294	60685	23391	1.63
T_5	37819	110518	72699	2.92
T_6	37240	108403	71163	2.91
T_7	38819	123093	84274	3.17
T_8	38240	114943	76703	3.01
T_9	39555	139073	99518	3.52
T_{10}	35015	52783	17768	1.51
SEm±	-	-	8421.21	0.23
CD (*p*=0.05)	-	-	24580.97	0.66

Groundnut seed: 25 ₹ kg^{-1}; Pendimethalin: 550 ₹ l^{-1}; Imazethapyr: 1905 ₹ l^{-1}; Quizalofop-ethyl: 1700 ₹ l^{-1}; Groundnut haulm: 10 ₹ kg^{-1}; Quizalofop-ethyl: 1700 ₹ l^{-1}; 1 US$= ₹ 62.53 in Oct, 2013

4. Conclusion

Application of pre-emergence pendiethalin @ 1 kg a.i. ha^{-1} fb post-emergence imazethapyr @ 75 g a.i. ha^{-1} at 25 DAS+1 intercultivation at 35 DAS gave comparable pod yield (21.81 q ha^{-1}) and maximum net returns on invested rupee (B:C ratio 3.17) hence use of this herbicides to weed control was a cheaper and economical method of weed control.

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