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# Integration of chemical and cultural methods for weed management in *kharif* groundnut

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**ABSTRACT**

*A field experiment was conducted to study the integrated weed management in groundnut (Arachis hypogaea L.) for consecutive three kharif seasons in 2010, 2011 and 2012 at Breeder Seed Production Farm of Orissa University of Agriculture and Technology, Bhubaneswar with 7 weed management treatments in four replications. Weed free check (two hand weeding at 20 and 40 DAS and manually uprooting of weeds at 60 DAS) was found more effective to control weeds in groundnut and recorded lowest weed density, weed dry matter , weed index and highest weed control efficiency. It was also recorded significantly highest growth and yield attributes in groundnut over all the other treatments viz. number of pods plant$^{-1}$, shelling per cent and pod yield. Pre-emergence application of pendimethalin 30 EC @ 1 kg. a.i. ha$^{-1}$ + one HW at 45 DAS alone or in combination with post emergence application of quizalofopethyl 5 EC @ 50 g. a.i ha$^{-1}$ at 20 DAS was found next superior treatment after weed free check in respect of all weed and crop parameters. Though weed-free check recorded significantly highest gross returns and net returns, which was 39,535/ha and 16,962/ha, respectively.Highest B:C ratio (1.84) was recorded in treatment having pre-emergence application of pendimethalin 30 EC @ 1 kg. a.i ha$^{-1}$ + one HW at 45 DAS in combination with post emergence application of quizalofopethyl 5 EC @ 50 g. a.i ha$^{-1}$ at 20 DAS which was found most economically feasible weed management practice for groundnut.*

***Keywords*:** Cultural methods, economics, groundnut, herbicides, weed dynamics, weed management, yield

Groundnut is an important oilseed crop of India which is cultivated in nearly 6 million ha area with the production of 7.5 million tonnes and average productivity of 1.27 t ha$^{-1}$. Groundnut is grown mainly in *kharif* season in India. It encounters severe problem of weed infestation especially in the early stages of growth, because the seedling emerges 7 to 10 days after sowing coupled with the slow growth in the initial stages. The weeds emerge fast and grow rapidly competing with the crop severely for the resources namely nutrients, light, and space and also transpire lot of valuable conserved water from the soil. On an average the loss of groundnut production in the country due to weeds has been estimated to the tune of 13-80% (Ghosh *et al*. 2000), 33 per cent (Mani *et.al*,1968) and 70 per cent (Prasad, 2002). Thus, weed control during initial stage of crop growth is essential to get optimum yield.Weed competition in early stages of crop growth affects the yield potential of the crop. Knowledge about competitive aspects of weeds and the critical stages at which the weeds compete with the crop to the maximum extent is an important aspect which needs to be understood for effective weed management. The co-existence of weeds with the crop plants cause considerable reduction in yield in crop plants by affecting both the growth and yield components. Though, physical methods of weed control are very effective, but they have certain limitations such as non-availability of labour during peak period, high labour cost, and unfavourable environmental conditions, such as rainfall during peak period. Under such conditions, the chemical weed control plays an important role in groundnut and enhances the groundnut yield substantially. Looking to the above facts the present experiment is planned to manage the weeds in groundnut with post emergence herbicides. The present study aimed to find out the effective and economic use of post emergence herbicides to control weeds in groundnut crop.

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## MATERIALS AND METHODS

The experiment was conducted at Breeder Seed Production Farm of Orissa University of Agriculture and Technology, Bhubaneswar, Odisha for three consecutive *kharif* seasons of 2010, 2011 and 2012 in randomized block design with 7 treatments replicated four times. The experimental site was located at 20.15ºN latitudes and 85.53ºE longitudes with average annual rainfall of 1520 mm. The soil of experimental field was medium deep with pH 5.9 and 280.0 kg, 14.0 kg and 175.0 kg ha$^{-1}$ available N, $P_2O_5$ and $K_2O$ respectively. The details of treatments are given in table 1. Bold and healthy seeds of groundnut were selected and treated with captan @ 2 g kg$^{-1}$ of seed. Groundnut variety *'Smruti'* was sown on 11$^{th}$ July in

2010, 12th July in 2011 and 15th July 2012 with plant spacing of 30 x 10 cm on flat beds and harvested on 1st November in 2010, 3rd November in 2011 and 5th November in 2012. Nitrogen, phosphorous and potassium were applied at the rate of 20 : 40 : 40 kg N, $P_2O_5$, and $K_2O$ $ha^{-1}$ in the form of urea, single super phosphate and muriate of potash respectively. The gypsum @ 250 kg $ha^{-1}$ was applied. The entire quantity of fertilizer was applied at the time of sowing in the furrows opened 5 cm away from the seed line and later furrows were covered with soil except gypsum, which was applied at 21 DAS. The inter cultivation and hand weeding were carried out as per the treatment details. The post emergence application of herbicides such as Quizalofop-p-ethyl and Imazethapyr was applied during 20 days after sowing as per the treatments. Quizalofop-p-ethyl [Ethyl-2-{4-{6-chloro-2quinaxolinyl) oxy}phenoxy}propionate] belongs to the phenoxy propionic acids. This herbicide mainly propionic acid derivative or have propionic acid side chain and, therefore this is called as "aryloxyphenoxy propionates." Quizalofop-p-ethyl is a selective, post emergence phenoxy herbicide. Quizalofop-p- ethyl is a Co-A Carboxylase (ACCase) inhibitors. Quizalofop-p-ethyl is an acetyl CoA Carboxylase inhibitor and inhibits the fatty acid biosynthesis. It is absorbed from the leaf surface with translocation throughout the plant, moving in both xylem and phloem, and accumulating in the meristematic tissue. Imazethapyr [2-{4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl}-5-ethyl-3-pyridine carboxylic acid] belongs to the Imidazolinones group. It is an Imidazolinones herbicide, absorbed by the foliage and roots with rapid translocation in the xylem and phloem to the meristematic regions where it accumulates. It inhibits the Acetolactate synthatase (ALS) or acetohydroxy acid synthatase (AHAS) inhibitors. Pendimethalin was applied one day after sowing as pre-emergence, whereas quizalofop-p-ethyl and imazethapyr was applied 20 days after sowing as post-emergence as per the treatment details (Table 1) with knapsack sprayer. Weed free check was achieved by three hand weedings at 20, 40 and 60 DAS. Randomly five plants were selected from each plot and regular biometric observations of crop and weed parameters were recorded from 30 DAS up to harvest. Weed density (no. $m^{-2}$) and dry weight of weeds (g $m^{-2}$) were recorded by putting a quadrate of 0.25$m^2$ at two random spots in each plot. Weed control efficiency and weed index was calculated by standard formulae. The yield parameters and yields were recorded and analyzed as per Gomez and Gomez (1984). The treatment comparisons were made using t-test at 5% level of significance. For economics study, prevailing market price was used for different outputs and inputs.

## RESULTS AND DISCUSSION

### Effect on weed growth

Predominant weeds found in experimental groundnut field were: *Parthenium hysterophorus, Amaranthus viridis, Portulaca oleracea, Argemone mexicana, Euphorbia hirta, Solanum nigrum, Cleome viscosa, Echinochloa colonum, Cyperus rotundus* and *Cynodon dactylon*. All the treatments were responsible for significant reduction in weed density and dry weight of weeds over unweeded control. Treatment of weed free check resulted in lowest weed density and dry weight of weeds. However, treatment pre-emergence application of pendimethalin 30 EC @ 1 kg. a.i. $ha^{-1}$ + one HW at 45 DAS alone or in combination with post emergence application of quizalofopethyl 5 EC @ 50 g a.i. $ha^{-1}$ at 20 DAS were found to be *at par* with each other in respect of weed population. Other than treatment of weed free check, pre-emergence application of pendimethalin 30 EC @ 1 kg. a.i. $ha^{-1}$ + one HW at 45 DAS alone or in combination with post emergence application of quizalofopethyl 5 EC @ 50 g. a.i. $ha^{-1}$ at 20 DAS recorded significantly the lower dry weight of weeds than other treatments.

Highest weed control efficiency were observed in weed free check. Pre-emergence application of pendimethalin 30 EC @ 1 kg. a.i. $ha^{-1}$ + one HW at 45 DAS alone or in combination with post emergence application of quizalofopethyl 5 EC @ 50 g. a.i. $ha^{-1}$ at 20 DAS was found next superior treatment after weed free check in respect of all weed parameters including weed control efficiency(79.3 and 87.2% at 30 and 60 DAS respectively). This might be due to pre-emergence application of pendimethalin which prevented emergence of monocot and grassy weeds by inhibiting root and shoot growth, while quizalofopethyl was responsible for inhibition of acetolactate synthase (ALS) or acetohydroxy acid synthase (AHAS) in weeds which caused destruction of these weeds at 3-4 leaf stage (Solanki *et al*., 2005). Remaining monocot weeds were controlled by hand weeding at 45 DAS. Lowest weed control efficiency were recorded in weedy check (unweeded control). Similar observations on integration of hand weeding with pre and post-emergence herbicides resulted significant reduction in dry matter production by

**Table 1: Weed population,dry matter and control efficiency in groundnut as influenced by different treatments (Pooled)**

| | Treatments | No. of weeds per $m^{-2}$ | | Weed dry matter per $m^{-2}$ | | Weed control efficiency (%) | |
|---|---|---|---|---|---|---|---|
| | | 30 DAS | 60 DAS | 30 DAS | 60 DAS | 30 DAS | 60 DAS |
| $T_1$ | Unweeded control | 236.3 | 372.2 | 130.9 | 156.6 | - | - |
| $T_2$ | Weed free check | 0.0 | 0.0 | 0.0 | 0.0 | 100 | 100 |
| $T_3$ | Pendimethalin 30 EC @ 1 kg. a.i.$ha^{-1}$ + one HW at 45 DAS | 151.0 | 235.0 | 50.4 | 27.3 | 61.5 | 82.6 |
| $T_4$ | Quizalofopethyl 5 EC @ 50 g a.i.$ha^{-1}$ at 20 DAS | 185.0 | 306.1 | 65.9 | 35.8 | 49.7 | 77.1 |
| $T_5$ | Imazethapyr 10 WC @ 75 g a.i.$ha^{-1}$ at 20 DAS | 182.3 | 324.3 | 80.9 | 39.1 | 38.2 | 75.0 |
| $T_6$ | $T_3 + T_4$ | 150.7 | 238.2 | 27.1 | 20.1 | 79.3 | 87.2 |
| $T_7$ | $T_3 + T_5$ | 132.9 | 245.6 | 37.7 | 22.7 | 71.2 | 85.5 |
| | **SEm( ±)** | **3.1** | **2.2** | **1.1** | **1.5** | **-** | **-** |
| | **LSD (0.05)** | **9.2** | **6.5** | **3.2** | **4.4** | **-** | **-** |

weeds (Walia *et al*., 2007). Dubey and Gangwar (2012) have also found lower weed biomass, and higher weed control efficiency with post-emergence application of quizalofopethyl and two hand weeding in groundnut.

**Effect on yield and yield attributes**

Weed-free treatment recorded significantly higher pod , haulm yield per hectare, number of pods/plant and shelling per cent over all the other treatments in all the three years of study as well as in pooled data. This was followed by treatment of pre-emergence application of pendimethalin 30 EC @ 1 kg. a.i.$ha^{-1}$ + one HW at 45 DAS alone(774 kg pod $ha^{-1}$) or in combination with post emergence application of quizalofopethyl 5 EC @ 50 g. a.i.$ha^{-1}$ at 20 DAS(1563 kg pod $ha^{-1}$). Pod yield increased by 118.5% under weed free and 92.5% with treatment pre-emergence application of pendimethalin 30 EC @ 1 kg. a.i.$ha^{-1}$ + one HW at 45 DAS in combination with post emergence application of quizalofopethyl 5 EC @ 50 g. a.i.$ha^{-1}$ at 20 DAS This might be due to minimizing the competition of weeds with main crop for resources *viz*. space, light, nutrients and moisture with adaption of effective weed management methods. Singh and Giri (2001) have also concluded that proper weed control was responsible for increase in pod yield and yield attributes in groundnut. Weed free environment in crop also facilitated better peg initiation and development at the critical growth stages of groundnut which tends to increase in number of pods/plant and pod yield $ha^{-1}$. Higher profitable pod yield of summer and kharif groundnut was also reported by Raj *et al*. (2008) and Kumar *et al*.(2013*)* under weed free condition,respectively. Significantly lower values of number of pods and pod yield $ha^{-1}$ were recorded in plots with unweeded control.

**Economics**

Weed-free check recorded significantly highest gross returns (Rs.39,535 $ha^{-1}$) and net returns (Rs.16,962 $ha^{-1}$), respectively whereas highest B:C ratio (1.84) was recorded in treatment of pre-emergence application of pendimethalin 30 EC @ 1 kg. a.i.$ha^{-1}$ + one HW at 45 DAS in combination with post emergence application of quizalofopethyl 5 EC @ 50 g. a.i.$ha^{-1}$ at 20 DAS. This is accorded to higher cost of cultivation of groundnut with weed free check involving more human labours and higher wages. This cost was reduced in treatment pre-emergence application of pendimethalin 30 EC @ 1 kg. a.i.$ha^{-1}$ + one HW at 45 DAS in combination with post emergence application of quizalofopethyl 5 EC @ 50 g. a.i.$ha^{-1}$ at 20 DAS by using herbicides effectively manage weeds with minimizing human labours. Sasikala *et al.*(2004) and Rao *et al.* (2011) have also reported higher net return and B:C ratio with integration of pre- and post emergence application of herbicides with hand weeding in groundnut. Weedy check (unweeded control) recorded lowest gross monetary return (Rs. 18,375 $ha^{-1}$), net monetary return (Rs. 905 $ha^{-1}$) and B:C ratio (1.05).

**Table 2: Dry pod and haulm yield of groundnut as influenced by different treatments (Pooled)**

| | Treatments | Dry pod yield(kg ha$^{-1}$) | | | | Percent | Dry haulm yield(kg ha$^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2010 | 2011 | 2012 | Pooled | increase | 2010 | 2011 | 2012 | Pooled |
| $T_1$ | Unweeded control | 851 | 644 | 942 | 812 | - | 1974 | 1323 | 2045 | 1781 |
| $T_2$ | Weed free check | 1893 | 1514 | 1916 | 1774 | 118.5 | 3017 | 2999 | 3550 | 3189 |
| $T_3$ | Pendimethalin 30 EC @ 1 kg. a.i.ha$^{-1}$ + one HW at 45 DAS | 1510 | 1110 | 1555 | 1392 | 71.4 | 2774 | 2500 | 3010 | 2761 |
| $T_4$ | Quizalofopethyl 5 EC @ 50 g a.i.ha$^{-1}$ at 20 DAS | 1405 | 1106 | 1480 | 1330 | 63.8 | 2672 | 2367 | 2710 | 2583 |
| $T_5$ | Imazethapyr 10 WC @ 75 g a.i.ha$^{-1}$ at 20 DAS | 1394 | 1044 | 1390 | 1276 | 57.1 | 2560 | 2259 | 2590 | 2470 |
| $T_6$ | $T_3 + T_4$ | 1620 | 1374 | 1694 | 1563 | 92.5 | 2878 | 3094 | 3116 | 3029 |
| $T_7$ | $T_3 + T_5$ | 1542 | 1168 | 1585 | 1432 | 76.4 | 2813 | 2558 | 2912 | 2761 |
| | **SEm( ±)** | **62** | **22.1** | **31.1** | **23** | **-** | **71** | **54** | **21.0** | **29.4** |
| | **LSD (0.05)** | **186** | **66.2** | **92.9** | **68** | **-** | **211** | **161** | **62.8** | **87.9** |

**Table 3: Yield attributes and economics of groundnut as influenced by different treatments (Pooled)**

| | Treatments | pods plant$^{-1}$ | Shelling per cent | Cost of cultivation (Rs. ha$^{-1}$) | Gross return (Rs. ha$^{-1}$) | Net return (Rs. ha$^{-1}$) | B:C ratio | Weed index (%) |
|---|---|---|---|---|---|---|---|---|
| $T_1$ | Unweeded control | 7.9 | 59.7 | 17469 | 18375 | 905 | 1.05 | - |
| $T_2$ | Weed free check | 23.4 | 62.0 | 22573 | 39535 | 16962 | 1.76 | 54.2 |
| $T_3$ | Pendimethalin 30 EC @ 1 kg. a.i.ha$^{-1}$ + one HW at 45 DAS | 18.8 | 60.6 | 18595 | 31097 | 12501 | 1.67 | 41.7 |
| $T_4$ | Quizalofopethyl 5 EC @ 50 g a.i.ha$^{-1}$ at 20 DAS | 18.4 | 60.4 | 14971 | 29728 | 14757 | 2.04 | 38.9 |
| $T_5$ | Imazethapyr 10 WC @ 75 g a.i.ha$^{-1}$ at 20 DAS | 17.7 | 60.1 | 19076 | 28523 | 9446 | 1.50 | 36.4 |
| $T_6$ | $T_3 + T_4$ | 15.5 | 60.7 | 19103 | 34835 | 15731 | 1.84 | 48.0 |
| $T_7$ | $T_3 + T_5$ | 17.4 | 60.8 | 18934 | 32017 | 13082 | 1.70 | 43.3 |
| | **SEm( ±)** | **0.25** | **0.17** | **511** | **490** | **267** | **0.027** | **-** |
| | **LSD (0.05)** | **0.74** | **0.51** | **1528** | **1464** | **804** | **0.080** | **-** |

*Selling price of groundnut pod =* ***23 kg$^{-1}$***

From the present study it can be concluded that pre-emergence application of pendimethalin 30 EC @ 1 kg. a.i.ha$^{-1}$ + one HW at 45 DAS in combination with post emergence application of quizalofopethyl 5 EC @ 50 g a.i.ha$^{-1}$ at 20 DAS proved practically more convenient and economically best feasible integrated weed management practice for groundnut considering the present condition of scarcity and high cost of labours, quality of weed control, yield and B:C ratio of cultivation of groundnut.

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