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# Weed management in no-tilled dribbling maize for small land holder

**Pijush Kanti Mukherjee* and Anwesh Rai**
*Department of Agronomy, Uttar Banga Krishi Viswavidyalaya, Cooch Behar, West Bengal 736 164*

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**ABSTRACT**

A field experiment was carried out during winter (*Rabi*) seasons of 2012-13 and 2013-14 at research farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal with the objectives to study the weed control practices in no-tilled dibbling maize within rice residues. The experiment consisted of eight treatments, comprising of varying doses of 2,4-D (post-emergence treatment), atrazine with sequential application as pre-emergence and post-emergence treatment, pendimethalin followed by atrazine, weedy check and complete weed-free treatments, laid out in randomised block design (RBD) with four replications. Highest weed control efficiency and lowest weed index values were registered by atrazine 1.0 kg/ha as pre-emergence + atrazine 1.1 kg/ha as post-emergence. The dominant weed flora were the broad-leaved weeds *Polygonum persicaria, P. pensylvanicum, P. orientale,* and the grasses *Digitaria ciliaris, Setaria glauca.* Among the weed control practices, season long weed free condition recorded the highest grain/kernel yield of maize (9.52 and 10.6 t/ha) during both the years, which was statistically at par with atrazine 1.0 kg/ha as pre-emergence + atrazine 1.1 kg/ha as post-emergence (9.3 and 10.4 t/ha) and atrazine 0.75 kg/ha as pre-emergence + atrazine 1.1 kg/ha as post-emergence (9.07 and 10.12 t/ha). The atrazine 1.0 kg/ha as pre-emergence + atrazine 1.1 kg/ha as post-emergence gave maximum net return of (` 93,650/ha and ` 1,21,050/ha) and maximum net return per rupee invested (1.88 and 2.31).

**Key words:** Atrazine, Chemical control, No-tilled dibbling maize, Pendimethalin, Small land holder

Maize or corn (*Zea mays* L.) is the most versatile crop having wider adaptability under varied agro-climatic conditions with highest genetic yield potential among the cereals. Hence, it is referred to as 'Queen of Cereals' or 'Miracle Crop'. It is cultivated throughout the year in all states of country. In India, maize is the third most important food crops after rice and wheat. Currently, it is cultivated in India in an area of 8.49 mha with a production of 21.28 million ton and productivity of 2.51 t/ha (Rao *et al*., 2014). In this region of West Bengal, maize is generally cultivated at the terminal part of the winter season *i.e.* before the beginning of *pre-Kharif* (summer season). Severe infestation by weeds is considered as a major constraint in maize cultivation. Uncontrolled weeds in maize caused yield reduction in the range of 40 to 60% depending upon the intensity and types of weed flora (Sunitha and Kalyani 2012). Increased weed problems and other irreversible damage caused by conventional tillage practices led to the need of exploring alternate crop establishment techniques.

Conservation agriculture (CA) is now widely recognized as a viable concept for practicing sustainable agriculture. CA holds tremendous potential for all size of farm and agro-ecological system, but its adaptation is probably most urgently required by small land holder (FAO 2006). It has been the greatest challenge to bring the small land holder under conservation tillage practices as small fragmented lands became inaccessible for operating tractor driven 6 or 11 tynes zero tillage machines. Therefore, no-tilled dibbling crop establishment technique was taken into consideration for adopting conservation tillage practices in small fragmented lands dominated in these areas. In view of the importance of weed control in no-tilled condition, field experiment was conducted in no-tilled dibbling maize within rice anchor residues with the objectives to study the weed control practices in no-tilled dibbling maize and to work out the economics of maize cultivation.

## METERIALS AND METHODS

A field experiment was conducted during two consecutive winter (*Rabi*) seasons of 2012-13 and 2013-14 at research farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal. The soil of the experiment was sandy loam in texture having a pH 5.45 with 0.62% organic carbon, low in available nitrogen (112.25 and 115.50 kg N/ ha), medium in available phosphorus (18.21 and

***Corresponding author:** pkm_agronomy@yahoo.co.in
Indian Veterinary Research Institute (IVRI), Izatnagar, Bareilly, Uttar Pradesh 243 122

17.50 kg $P_2O_5$ /ha) and low in available potassium (80.53 and 92.23 kg $K_2O$/ha) during both the year of experimentation. Eight treatments comprising of varying doses of 2,4-D (post-emergence treatment), atrazine with sequential application as pre-emergence and post-emergence treatment, pendimethalin followed by atrazine, weedy check and complete weed-free treatments were laid out in randomised block design (RBD) with four replications. 2,4-D sodium salt and pendimethalin (38.7% EC) was used during first year and 2,4-D ethyl-ester and pendimethalin (30% EC) was used during 2nd year of experimentation.

A small locally made narrow iron spade known as dibbler was used to open the hole/slot within rice anchor residue in which hybrid maize seeds (Variety *900 M Gold*) were dibbled manually at the depth of 6 cm at 60 x 30 cm spacing with the seed rate of 19 kg/ ha. Glyphosate (1.5 kg/ha) was applied one week before sowing as pre-plant desiccators. Pre-sowing irrigation was given four days before sowing operation. The NPK ratio of 130:60:85 kg/ha was applied. Vermicompost 200 kg/ha, fertilizer mixture (10:26:26) 225 kg/ha, mixture of chloropyriphos (500 ml trade product) + rice husk (2 kg) + molasses (250 g) per 1333 $m^2$ were applied together with handful mixture at the time of dibbling. Urea was top-dressed in two split doses (113 kg/ha each) during 28-30 days after sowing (DAS) and 50-55 DAS. MOP (45 kg/ha) was also top dressed during 50-55 DAS along with final top dressing of nitrogenous fertilizer. A knapsack sprayer fitted with flat fan nozzle using 550 litres of water per hectare was used for spraying the herbicide. Weed population was taken by quadrate method and dry weight was done as per standard method. Data on weed dry weight was subjected to "x+1" square root transformation to normalize the distribution. The grain yield of maize was recorded at harvest from the net plot area. Economics of the treatments was computed based on prevalent market price.

## RESULTS AND DISCUSSION

### Effects on weeds

The experimental field was infested with grasses, sedges and broad-leaved weeds. The grasses *Cynodon dactylon, Setaria glauca, Digitaria ciliaris,* the broad-leaved weeds *Polygonum pensylvanicum, Polygonum orientale* and *Polygonum persicaria, Stellaria media, Stellaria aquatic, Oldenlandia diffusa, Hydrocotyl ranunculoides, Chenopodium album, Solanum nigrum, Physalis minima* and *Ageratum conyzoides* and the sedge *Cyperus rotundus,* were recorded in the experimental field during both the year of experimentation. Higher values of 'Importance Value Index' (IVI) and 'Summed Dominance Ratio' (SDR) of species like *Polygonum, Stellaria media, Oldenlandia diffusa, Digitaria ciliaris* and *Setaria glauca* at 35 DAS and 75 DAS indicated higher persistence and aggressive nature of these weeds during the crop growth. Other broad-leaved weeds like *S. aquatica, C. album, P. minima, S. nigrum, Oxalis corniculata* and *Hydrocotyl ranunculoides* and sedge *C. rotundus* recorded moderate values of these parameters indicating less aggressive nature of these weeds. The values of per cent contribution of total weed population also indicated dominance of *Polygonum* sp., *O. diffusa, S. glauca* and *D. ciliaris* during the crop growth (Table 1). Among the weed flora, broad-leaved weeds were more aggressive than that of grasses and sedges. The broad-leaved weeds *A. conyzoides, O. corniculata* and *H. ranunculoides* appeared only during 2nd year of experimentation at the later part of the crop growth indicating the invasion capacity of this weed in maize.

Among the weed control practices, the lower dose of atrazine (0.75 kg/ha) as pre-emergence treatment was effective in inhibiting the germination and emergence of grasses and broad-leaf weeds, however, its residual toxicity in controlling those weeds was comparatively lower than that of higher dose (1.0 kg/ha) of atrazine. Among the treatments, lowest dry matter of the weeds at 35 DAS and 75 DAS was recorded in atrazine 1.0 kg/ha (pre-emergence) + atrazine 1.1 kg/ha (post-emergence) treatment, which was at par with the treatment atrazine 0.75 kg/ha (pre-emergence) + atrazine 1.1 kg/ha (post-emergence). Pendimethalin with the formulation of 38.7% EC at the dose of 0.90 kg/ha was less effective to control grasses and broad-leaved weeds during 1st year of experimentation, however, during 2nd year of experiment, pendimethalin with formulation of 30% EC at the dose of 0.70 kg/ha showed higher level of control in terms of reduction on weed dry weight. This result showed that weed control capacity of pendimethalin varied in variation of its commercial formulation. It was observed in the experiment that the broad-leaved weeds *Polygonum* sp., *S. media, P. minima* and *S. nigrum* showed tolerance against the action of 2,4-D **(**Mukherjee *et al.*, 2011). The results revealed that these weeds were not controlled effectively by the application of both formulations of 2,4-D (2,4-D sodium salt and ethyl ester) with the doses of 0.50 kg/ ha, 0.75 kg/ha and 1.0 kg/ha. Highest weed control efficiency value and lowest weed index value were

recorded by the treatments atrazine 1.0 kg/ha (pre-emergence) + atrazine kg/ha (post-emergence) closely followed by the treatment atrazine 0.75 kg/ha (pre-emergence) + atrazine 1.1 kg/ha (post-emergence) indicated the selective nature of his herbuicde in controlling weeds without causing phytotoxicity on maize plant (Table 2). Kumar *et al.* (2012) also reported that atrazine followed by atrazine resulted in highest weed control efficiency of 80.3% which was followed by sequential application of pendimethalin and atrazine. These findings also corroborate with the findings of Deshmukh *et al.* (2014), Gopinath *et al.* (2008) and Madhavi *et al.* (2014). Advancement of sowing to last week of November in 2nd year of experimentation improved weed control efficiency to the tune of 5.34% at 35 DAS and 11.1% at 75 DAS on the basis of weed growth in weedy check treatment. Weeds in weedy check treatment have the capacity to cause yield reduction to the tune of 60.7 to 62.3%.

**Effect on yield**

Among weed control treatments, season long weed free condition registered highest value of grain yield (9.6 and 10.6 t/ha), which was closely followed by the treatment atrazine 1.0 kg/ha (pre-emergence) + atrazine 1.1 kg/ha (post-emergence) (9.3 and 10.4 t/ha) and the treatment atrazine 0.75 kg/ha (pre-emergence) + atrazine 1.1 kg/ha (post-emergence) (9.1 and 10.1 t/ha) without having any significant difference among each other (Table 2). Even though the treatments atrazine 1.0 kg/ha (pre-emergence) + atrazine 1.1 kg/ha (post-emergence) and atrazine 0.75 kg/ha (pre-emergence) + atrazine 1.1 kg/ha (post-emergence) were statistically at per among each other in terms of grain yield, however, 2.48 to 2.75% yield increment was recorded by increasing dose of atrazine from 0.75 kg/ha to 1.0 kg/ha as pre-emergence coupled with atrazine 1.1 kg/ha as post-emergence. Yield increment 11.65% was recorded due to advancement of sowing during 2nd year of experimentation. Yield increment to the tune of 15.41% was registered by changing the pendimethalin from 38.7% EC formulation of 0.90 kg/ha to 30% EC formulation of 0.70 kg/ha coupled with atrazine 1.1 kg/ha as post-emergence and advancement of sowing to last week of November (Table 2).

**Economic impact**

The treatment atrazine 1.0 kg/ha (pre-emergence) + atrazine 1.1 kg/ha (post-emergence), gave the maximum net return (₹93,650 and 1,21,050/ ha) and net return per rupee invested (1.88 and 2.31) which was followed by the treatment atrazine 0.75 kg/ha (pre-emergence) + atrazine 1.1 kg/ha (post-emergence) (90,960 and 1,17,500/ha) (Table 2). Even though the treatments atrazine 1.0 kg/ha (pre-emergence) + atrazine 1.1 kg/ha (post-emergence) and atrazine 0.75 kg/ha (pre-emergence) + atrazine 1.1 kg/ha (post-emergence) were statistically at per among each other in terms of grain yield, however, more investing as input cost to the tune of ` 180 to 195.00/ha for increasing the dose of atrazine from

**Table 1. Relative density (RD), relative frequency (%), importance value index (IVI) and summed dominance ratio (SDR) and per cent of total weed population of weed flora appeared in weedy check treatment**

| Weed species | Relative Density (RD) | | | | Relative Frequency (%) | | | | Importance Value Index (IVI) | | | | Summed Dominance Ratio (SDR) | | | | Per cent of total Weed population (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Y1 | Y2 | Y1 | Y2 | Y1 | Y2 | Y1 | Y2 | Y1 | Y2 | Y1 | Y2 | Y1 | Y2 | Y1 | Y2 | Y1 | Y2 | Y1 | Y2 |
| | 35 DAS | 35 DAS | 75 DAS | 75 DAS | 35 DAS | 35 DAS | 75 DAS | 75 DAS | 35 DAS | 35 DAS | 75 DAS | 75 DAS | 35 DAS | 35 DAS | 75 DAS | 75 DAS | 35 DAS | 35 DAS | 75 DAS | 75 DAS |
| *Polygonum persicaria* | 19.3 | 17.2 | 15.7 | 14.33 | 9.30 | 7.84 | 9.52 | 7.41 | 28.7 | 25.0 | 25.25 | 21.74 | 14.33 | 12.50 | 12.62 | 10.87 | 19.35 | 17.16 | 15.73 | 14.33 |
| *Polygonum pensylvanicum* | 16.8 | 14.2 | 11.3 | 10.19 | 9.30 | 7.84 | 9.52 | 7.41 | 26.1 | 22.0 | 20.81 | 17.60 | 13.07 | 11.03 | 10.41 | 8.80 | 16.85 | 14.21 | 11.29 | 10.19 |
| *Polygonum orientale* | 8.24 | 8.58 | 7.66 | 7.96 | 9.30 | 7.84 | 9.52 | 7.41 | 17.5 | 16.4 | 17.19 | 15.37 | 8.77 | 8.21 | 8.59 | 7.68 | 8.24 | 8.58 | 7.66 | 7.96 |
| *Stellaria media* | 11.5 | 12.9 | 7.26 | 9.24 | 9.30 | 7.84 | 9.52 | 7.41 | 20.8 | 20.7 | 16.78 | 16.64 | 10.39 | 10.36 | 8.39 | 8.32 | 11.47 | 12.87 | 7.26 | 9.24 |
| *Stellaria aquatica* | 4.30 | 5.90 | 4.44 | 2.55 | 6.98 | 5.88 | 7.14 | 3.70 | 11.3 | 11.8 | 11.58 | 6.25 | 5.64 | 5.89 | 5.79 | 3.13 | 4.30 | 5.90 | 4.44 | 2.55 |
| *Oldenlandia diffusa* | 10.0 | 10.5 | 7.66 | 7.01 | 9.30 | 5.88 | 9.52 | 7.41 | 19.3 | 16.3 | 17.19 | 14.41 | 9.67 | 8.17 | 8.59 | 7.21 | 10.04 | 10.46 | 7.66 | 7.01 |
| *Solanum nigrum* | 4.30 | 4.83 | 3.23 | 3.82 | 4.65 | 5.88 | 4.76 | 7.41 | 8.95 | 10.7 | 7.99 | 11.23 | 4.48 | 5.35 | 3.99 | 5.61 | 4.30 | 4.83 | 3.23 | 3.82 |
| *Physalis minima* | 2.87 | 3.22 | 3.23 | 3.50 | 6.98 | 7.84 | 4.76 | 7.41 | 9.84 | 11.1 | 7.99 | 10.91 | 4.92 | 5.53 | 3.99 | 5.46 | 2.87 | 3.22 | 3.23 | 3.50 |
| *Oxalis corniculata* | 0.00 | 0.00 | 4.44 | 5.10 | 0.00 | 3.92 | 0.00 | 3.70 | 0.00 | 3.92 | 4.44 | 8.80 | 0.00 | 1.96 | 2.22 | 4.40 | 0.00 | 0.00 | 4.44 | 5.10 |
| *Chenopodium album* | 2.87 | 4.02 | 1.61 | 1.91 | 4.65 | 3.92 | 4.76 | 3.70 | 7.52 | 7.94 | 6.37 | 5.61 | 3.76 | 3.97 | 3.19 | 2.81 | 2.87 | 4.02 | 1.61 | 1.91 |
| *Ageratum conyzoides* | 0.00 | 0.00 | 4.84 | 2.55 | 0.00 | 5.88 | 0.00 | 7.41 | 0.00 | 5.88 | 4.84 | 9.96 | 0.00 | 2.94 | 2.42 | 4.98 | 0.00 | 0.00 | 4.84 | 2.55 |
| *Hydrocotyl ranunculoides* | 0.00 | 0.00 | 6.05 | 2.55 | 0.00 | 3.92 | 0.00 | 5.56 | 0.00 | 3.92 | 6.05 | 8.10 | 0.00 | 1.96 | 3.02 | 4.05 | 0.00 | 0.00 | 6.05 | 2.55 |
| *Cyperus rotundus* | 3.23 | 3.22 | 4.44 | 5.41 | 6.98 | 5.88 | 7.14 | 5.56 | 10.2 | 9.10 | 11.58 | 10.97 | 5.10 | 4.55 | 5.79 | 5.48 | 3.23 | 3.22 | 4.44 | 5.41 |
| *Digitaria ciliaris* | 6.45 | 7.24 | 8.06 | 8.92 | 9.30 | 7.84 | 9.52 | 7.41 | 15.7 | 15.1 | 17.59 | 16.32 | 7.88 | 7.54 | 8.79 | 8.16 | 6.45 | 7.24 | 8.06 | 8.92 |
| *Setaria glauca* | 5.73 | 5.90 | 7.26 | 10.19 | 9.30 | 7.84 | 9.52 | 7.41 | 15.0 | 13.7 | 16.78 | 17.60 | 7.52 | 6.87 | 8.39 | 8.80 | 5.73 | 5.90 | 7.26 | 10.19 |
| *Cynodon dactylon* | 4.30 | 2.41 | 2.82 | 4.78 | 4.65 | 3.92 | 4.76 | 3.70 | 8.95 | 6.33 | 7.58 | 8.48 | 4.48 | 3.17 | 3.79 | 4.24 | 4.30 | 2.41 | 2.82 | 4.78 |

Y1 = First year (2012-13). Y2 = Second year (2013-14). DAS- Days after sowing

**Table 2. Weed control efficiency, weed index, grain/kernel yield and economics of maize as influenced by different weed management treatments**

| Treatment | Weed control efficiency (%) at 35 DAS | | Weed control efficiency (%) at 75 DAS | | Weed index (%) | | Grain yield (t/ha) | | Net return (×10$^3$ ₹/ha) | | Net return per rupee invested (₹) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2012-13 | 2013-14 | 2012-13 | 2013-14 | 2012-13 | 2013-14 | 2012-13 | 2013-14 | 2012-13 | 2013-14 | 2012-13 | 2013-14 |
| 2,4-D 0.50 kg/ha | 3.17 | 0.80 | 38.5 | 42.8 | 47.21 | 45.00 | 5.03 | 5.83 | 35.11 | 51.23 | 0.73 | 1.00 |
| 2,4-D 0.75 kg/ha | 2.44 | 1.31 | 47.4 | 53.7 | 45.22 | 43.41 | 5.21 | 5.96 | 38.57 | 52.91 | 0.80 | 1.02 |
| 2,4-D 1.00 kg/ha | 2.85 | 1.17 | 48.6 | 56.0 | 43.63 | 42.45 | 5.33 | 6.05 | 43.76 | 54.09 | 0.90 | 1.04 |
| Pendimethalin {0.90 kg/ha (Y1) 0.70 kg/ha (Y2)}+ atrazine 1.1 kg/ha | 61.65 | 68.63 | 63.4 | 74.3 | 16.23 | 12.82 | 7.95 | 9.18 | 75.05 | 101.53 | 1.49 | 1.92 |
| Atrazine 0.75 kg/ha+ atrazine 1.1 kg/ha | 69.31 | 73.39 | 71.1 | 77.4 | 4.54 | 3.39 | 9.08 | 10.12 | 90.96 | 117.50 | 1.83 | 2.25 |
| Atrazine1.00 kg/ha+ atrazine 1.1 kg/ha | 74.37 | 77.03 | 76.7 | 80.4 | 2.05 | 1.25 | 9.30 | 10.40 | 93.65 | 121.05 | 1.88 | 2.31 |
| Weedy check | 00.0 | 00.0 | 00.0 | 00.0 | 60.74 | 62.34 | 3.76 | 3.95 | 19.71 | 27.10 | 0.41 | 0.53 |
| Complete weed-free | 100 | 100 | 100 | 100 | 00.0 | 00.0 | 9.56 | 10.64 | - | - | - | - |
| LSD (P=0.05) | | | - | - | - | - | 0.97 | 1.37 | - | - | - | - |

Y1 = First year (2012-13). Y2 = Second year (2013-14). DAS = Days after sowing. Minimum support price in the year 2012-13- ₹117/t . Minimum support price in the year 2013-14- 131/t.

0.75 kg/ha to 1.0 kg/ha resulted in obtaining more net return to the tune of ` 2,689 to ` 3,550/ha. More net return to the tune of ` 27,400/ha was obtained during 2nd year of experimentation in the treatments atrazine 1.0 kg/ha (pre-emergence) + atrazine 1.1 kg/ha (post-emergence) and this was mainly due to higher minimum support price, higher grain yield because of advancement of sowing and better weed control.

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